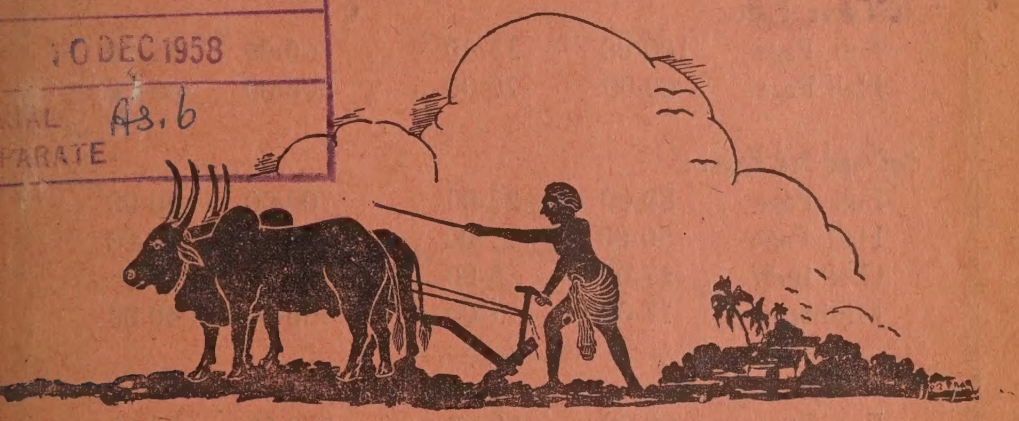
The Mysore Agricultural Journal

(The Journal of the Mysore Farmers' Forum)

Vol. XXXIII] April—June 1958 [No. 2

MMONWEALTH INST.
TOMOLOGY LIBRARY
10 DEC 1958
A3.6
PARATE



IN THIS ISSUE

MANURING OF POTATOES IN RED SOILS OF MYSORE

PRESOWING TREATMENTS OF *CROTOLARIA STRIATA*

THE HAIRY CATERPILLAR PEST OF CARDAMOM

SIMULTANEOUS GREEN MANURING IN THE STANDING CROP OF DRILLED PADDY

COTTON CULTIVATION IN BELLARY DISTRICT

"COORG LIME"—A NEW VARIETY

FERTILISER REQUIREMENTS OF CROPS IN MYSORE STATE

MYSORE VYAVASAYA PATRIKA

ADVERTISEMENT RATES

	English Quarterly		Kannada Monthly	
	4 Issues consecutively	Single Insertion	12 Issues	Single Insertion
	Rs.	Rs.	Rs.	Rs.
4th Cover Page:				
Full Page	100·00	33·00	760·00	65·00
Half Page	60·00	20·00	500.00	45·00
2nd and 3rd Pages:				
Full Page	80·00	27·00	700·00	60·00
Half Page	50·00	17·00	460·00	40·00
One Inch	17·00	5·00	—	—
Minimum	17·00	5·00	460·00	40·00
Text Page:				
Full Page	60·00	20·00	580·00	50·00
Half Page	40·00	14·00	340·00	30·00
One Inch	10·00	3·00	—	—
Minimum	10·00	3·00	340·00	30·00

Pages Royal 8vo. $6\frac{1}{2}" \times 9\frac{1}{2}"$; Net Page $4\frac{5}{16}" \times 7\frac{5}{16}"$

Art Paper or Imitation Art or Colour Paper or Double Colour Advertisements extra

Please write to:

MYSORE VYAVASAYA SANGHA

(MYSORE FARMERS' FORUM)

CENOTAPH ROAD : : BANGALORE 2

The
Mysore Agricultural Journal

The Journal of the Mysore Farmers' Forum

Vol. XXXIII *April to June 1958* *No. 2*

President:

K. F. PATIL, B.A.,
Minister for Food and Agriculture.

Chairman:

M. MALLARAJ URS, B.Sc., B.Sc. (EDIN.),
Director of Agriculture and Commissioner for Food Production.

Vice-Presidents:

T. R. NESVI, M.P. V. MASIYAPPA.
L. T. KARLE. KANTHA RAO DESAI.

Secretaries:

R. NARASIMHIAH. S. V. HARIDAS.

Editor:

DR. H. R. ARAKERI.

Assistant Editors:

D. V. MURTHY. B. K. RAMA RAO.

(*The Mysore Agricultural Journal does not accept responsibility for facts or opinions expressed by contributors.*)

CONTENTS

PAGE

EDITORIALS

Water—Farmers' Friend and Foe 57

RESEARCH ARTICLE

Manuring of Potatoes (Solanum tuberosum) *in Red Soils of Mysore—Influence of Magnesium Salts on the Yield and Composition of Tubers*—By B. V. Venkata Rao and S. V. Govinda Rajan 58

Presowing Treatment of Seeds of Crotolaria striata *D.C.*—By C. Kempanna and S. B. Allayyanavaramath .. 63

Effect of Spacing-cum-*Nitrogen Application on the Yield of Sugarcane in Malnad Tract*—By S. V. Patil, M. B. Tippannavar and M. V. Kulkarni 66

The Hairy Caterpillar Pest of Cardamom—By S. V. Rajan .. 71

Brief Notes on Recent Investigations on Some Beneficial Parasites in Mysore—By Dr. M. Puttarudriah and S. Usman .. 76

An Unusual Mode of Feeding by Epilachna sparsa *H.* (*Coccinellidæ : Coleoptera*) *on Brinjal* (Solanum melongena *L.*)—By D. V. Murthy 80

A Note on Simultaneous Green Manuring in the Standing Crop of Drilled Paddy—By S. V. Patil and M. V. Kulkarni 81

GENERAL, REVIEW AND EXTENSION ARTICLES

A Note on Cotton Cultivation in Bellary District—By G. N. Alasingarachar 83

Improved Agricultural Practices as an Aid to Better Farming in Tungabhadra Project Area—By Ali Hyder and H. Purnapragnachar 87

" *Coorg Lime*"—*A New Variety*—By Dr. K. M. Aiyappa, P. P. Nanjappa and C. K. Subramanian 91

Prospects of Research and Development of Spices and Cashewnuts in India—By Dr. K. M. Aiyappa 93

The Present Position of Work Done on Fertiliser Requirements of Crops in Mysore State—By S. S. Sirur.. 98

The Agricultural Importance of the Interrelationship Between the Ion Exchange Capacities of Soil and Plant Root with reference to Nutrient Uptake by Plants—By T. Seshagiri Rao 108

RESEARCH IN PROGRESS 114

ABSTRACTS

Agricultural Chemistry 116

Agronomy 119

Entomology 119

NEWS AND NOTES 123

Editorial

WATER—FARMERS' FRIEND AND FOE

AMONG the numerous factors that affect plant growth, inadequate moisture supply in the soil becomes a limiting factor in crop production quite frequently than any other factor. More than 55% of the area of the world receives only 20 inches or less rainfall per year. Even in other areas where average rainfall is much higher than 20 inches, inadequate water-supply during certain phases of crop growth may affect growth and yield of crop considerably.

With a view to stabilising the yields at high level in the scarcity areas in particular and other areas in general, a number of major and minor irrigation projects have been taken up in the country. Top priority has been given to these projects and quite rightly too. But unfortunate experience in the areas where projects have been completed, is that the water that is made available for growing crops is not fully utilised. Only about 50% of the total irrigable areas is said to have been brought under irrigation.

Another undesirable experience in the old projects is the general tendency on the part of irrigators to use more and more water unnecessarily depriving off so many farmers from getting their due share even, with the result that large areas are going out of cultivation due to water-logging and development of salt lands.

It is the duty of every one of the beneficiaries and others concerned with irrigation projects, to see that the facilities provided are fully utilised in the interest of the country and the tendency of over irrigating the land which is beset with grave danger is checked right from the beginning. It must be mentioned here that old civilisations depending on irrigation agriculture have perished because of poor soil management practices. It is hoped that history would not repeat itself.

Research Articles

MANURING OF POTATOES (*SOLANUM TUBEROSUM*) IN RED SOILS OF MYSORE—INFLUENCE OF MAGNESIUM SALTS ON THE YIELD AND COMPOSITION OF TUBERS

By B. V. Venkata Rao[1] and S. V. Govinda Rajan[2]

Introduction

The growth and yield of potato (*Solanum tuberosum*) are usually influenced by the application of nitrogen and phosphatic fertilizers. However, potash applications are frequently necessary to balance the nutrients in the manure mixture. Experiments conducted in these laboratories indicate that the optimum dosage per acre under the conditions obtaining in the red soils of Bangalore and Kolar Districts is 50 lb. of N and 25 lb. of P_2O_5. It is found necessary to add 25 lb. of K_2O to maintain a proper balance.

The influence of other elements like Boron and Magnesium have been studied by Smith and Kelly (1946) and McGregor and Rost (1946). Little information however exists on the effect of these elements on this crop under Indian conditions. The possible effects of adding Magnesium and Boron salts in our soils on the growth of potato crop have been studied and the results obtained by the application of Magnesium salts are dealt with in this paper.

Experimental

The experiments were conducted during the summer and monsoon of the year 1949–50 and the data set out here refer particularly to the monsoon crop.

The experimental crop of potatoes was grown in plots enclosed by embedded cement cisterns of dimensions one yard square in the ground, the seed material being obtained from Simla. The soil is a red sandy loam typical of the potato-growing areas of the Bangalore

[1,2] Division of Agricultural Chemisry, Bangalore.

and Kolar Districts. The soils are well drained and their reaction neutral. The analytical data relating to the soil are given below:—

(i) Mechanical analysis Percentage on dry basis		(ii) Chemical analysis Percentage on dry basis	
Coarse sand ..	40·12	pH	6·9
Fine sand ..	29·88	Total N	0·059
Silt	6·72	Total P_2O_5 ..	0·049
Clay	19·28	Citric soluble P_2O_5	0·012
Organic Carbon ..	0·67	Total CaO ..	0·205
		Exchangeable CaO	0·200
		Total K_2O ..	0·084
		Exchangeable K_2O	0·004

The details of the treatments in the experiment are as follows:—

(1) Control—no manure.
(2) N only.
(3) N + P.
(4) N + P + K.
(5) N + P + K + Mg.
(6) N + P + K + 2 Mg.
(7) N + P + Mg.
(8) N + K + Mg.
(9) N + Mg.

N.B.—N=50 lb. of nitrogen per acre as a mixture of groundnut cake and Ammonium sulphate in the proportion of 3 : 1; P=25 lb. of P_2O_5 per acre as Superphosphate; K = 25 lb. of K_2O per acre as Sulphate of potash and Mg. = 12½ lb. of MgO per acre as Magnesium sulphate.

Each treatment was replicated 4 times and 12 plants were grown in each cistern. The yield from each cistern was separately recorded. Table I gives the average yield of the tubers from 4 replications in each treatment.

The above data show the treatments with nitrogen alone have marked influence on the yield and that addition of P and K do not appreciably improve the yield. The addition of magnesium in addition to nitrogen appears to increase the yield by about 10% while magnesium added with other mixtures shows no improvement in the yield. Representative samples of the tubers from each treatment were oven-dried and taken for analysis of N, P, K, Ca and Mg and the results obtained are detailed in Tables II and III.

TABLE I

Yield Data

Treatments	Yield of tubers in gm. per sq. yd.
1. Control	585·0
2. N only	799·5
3. N + P	773·5
4. N + P + K	859·0
5. N + P + K + Mg ..	873·3
6. N + P + K + 2 Mg ..	849·0
7. N + P + Mg	783·5
8. N + K + Mg	831·8
9. N + Mg	880·8

TABLE II

Composition of Potato Tubers on Moisture-Free Basis

Treatment	N %	Ash %	P_2O_5	CaO %	MgO %	K_2O %
1	0·89	3·66	0·606	0·071	0·184	2·32
2	1·25	3·09	0·616	0·076	0·192	2·63
3	1·29	3·42	0·772	0·105	0·168	2·21
4	1·21	3·51	0·766	0·077	0·174	2·62
5	1·13	3·92	0·782	0·075	0·181	1·85
6	1·03	4·55	0·826	0·066	0·162	2·06
7	0·99	3·66	0·796	0·072	0·177	3·84
8	1·05	3·93	0·762	0·065	0·167	3·23
9	0·93	4·05	0·802	0·084	0·174	3·15

A study of Table II shows that the phosphorus content of tubers is higher in all the treatments where magnesium has been added. Even in the absence of added phosphates as in treatments 8 and 9, addition of magnesium appears to have increased the phosphorus

TABLE III

Calculated Amount of Plant Nutrients Removed in the Tubers from an Area of 1 sq. yard

Treatment	N in gm.	P_2O_5 in gm.	K_2O in gm.
1	1·04	0·71	2·72
2	1·98	0·98	4·17
3	1·99	1·20	3·43
4	2·08	1·32	4·51
5	1·98	1·37	3·23
6	1·75	1·40	3·50
7	1·55	1·25	6·03
8	1·75	1·27	5·37
9	1·63	1·41	5·50

intake. With regard to potassium the presence of magnesium with or without potassium application has caused increased absorption of the element by the tubers. The potash content of tubers in treatments 7 and 9 where potassium has not been applied is appreciably higher than the other treatments. Nitrogen content of the tubers does not appear to be influenced by the magnesium treatments though the application of nitrogenous fertilizers alone or in combination has increased the protein content of the tubers as also the intake of phosphorus and potash. Though phosphorus intake of tubers improves with application of phosphatic fertilizers, this increased intake is more prominent when potash or magnesium is introduced into the mixture. The magnesium treatment is doubly beneficial in that both phosphorus and potash absorption are improved. This may be partly due to the increased solubilization of soil phosphates by addition of magnesium, and partly due to the replacement of potassium by this element from the clay complex and thereby increasing the available potash in the soil.

SUMMARY

An experiment on potatoes to study the influence of magnesium salts on the yield and intake of P and K was conducted in micro plots in the Pot Culture House. There were in all 9 treatments to include magnesium in different combinations with other plant food elements,

The results indicate that magnesium in combination with nitrogen alone appears to increase the yield of crop whereas when mixed with complete fertilizers no obvious advantage is gained. Additions of magnesium also appear to improve the absorption by the crop of P and K.

References

1. Smith, D. O. and Kelley, W. C. (1946), "Effect of Fertilizer rates, application," *American Potato Journal*, **23**, 4.

2. Mc Gregor and Rost, J. (1946), *American Soc. Agron.*, **38**, 7.

(Received: 2nd June 1958)

PRESOWING TREATMENT OF SEEDS OF *CROTOLARIA STRIATA* D.C.

By C. Kempanna[1] and S. B. Allayyanavaramath[2]

Introduction

Crotolaria striata D.C. commonly termed as 'wild sunnhemp' is an important green manure crop in plantations, particularly in cocoanut gardens of South India (Anon, 1958). Preliminary observations on the cultivation aspect of this crop at Hebbal had revealed that there is delayed and poor percentage of germination of seeds despite very favourable conditions with the result that in order to get a good stand of the crop thicker sowings have to be undertaken. This necessitates an increase in the seed rate and added to it there is the problem of retardation and unevenness in the rate of growth of crop.

The poor germination in *Crotolaria striata* is suspected to be due to hard seed-coat. Several methods have been developed for overcoming hard-coatedness in seeds before sowing. Common among these methods are soaking seeds in hot or boiling water. Early in the nineties, Rostrup, a Swedish Botanist had observed that concentrated sulphuric acid could be used to soften the outside layers of the hard seed-coats followed by thorough washing to remove all acid. Rubbing of seed on rough stone surface is suggested by Arakeri (1955) to remove dormancy due to hard seed-coat in cluster beans (*Cyamopsis psoralioides*, D.C.) Low concentration of colchicine has also been found to stimulate germination in certain seeds while higher doses inhibit germination or kill the seed altogether. Scarification of hard-coated seeds is also another practice in vogue and many machines have been invented and used commercially. A number of these machines have however proved useless as the impact breaks the embryos or results in injuries causing microbial infections.

Material and Methods

A preliminary investigation was undertaken at the Agricultural College, Hebbal, to find out an effective, simple and practicable method to overcome the hard-coatedness in *C. striata.* The following treatments were employed:—

(1) Soaking seeds in cold water for 24 hours; (2) Soaking in hot water for 1 hour, the temperature of which was fairly tolerable to touch; (3) Dipping in boiling water for 2 minutes; (4) Pounding the seed with coarse sand; (5) Treatment with concentrated sulphuric

[1, 2] Section of Botany, Agricultural College, Hebbal, Bangalore.

acid; and (6) Treatment with 0·4% aqueous solution of colchicine for 4 hours. The trials were carried out both in the Laboratory and the field simultaneously, all the treatments being replicated 4 times at random. The just emergence of the radicals from the seed in the Laboratory trials and that of the cotyledonary leaves in the field tests were used as the criterion for judging the germination performance. The observations were recorded till the 5th and 12th day after sowing in the Laboratory and field respectively. Maximum germination was noticed on the 2nd day in the Laboratory and the 7th day in the field.

Results

The percentage of germination observed in different treatments is recorded in Table I.

Table I

Sl. No.	Treatments	Percentage of germination in	
		Laboratory	Field
1	Control	8	6
2	Soaking in cold water for 24 hours	7	5
3	Soaking in hot water for 1 hour	42	32
4	Dipping in boiling water for 2 minutes	26	19
5	Scarification with Coarse Sand	89	55
6	Treatment with Conc. Sulphuric Acid	54	44
7	Treatment with 0·4% Colchicine for 4 hours	9	6

Of the various treatments, hot water, scarification and sulphuric acid showed good response with 32%, 55% and 44% germination respectively as compared with 6% germination in control and necessitated to standardise the technique to assure uniform treatment to all the seeds. The standardisation of the technique of scarification is very difficult as the degree of rubbing or pounding the seeds is dependent more upon the extent of physical force applied. As regards the other two, the following treatments were accorded to seeds and the results obtained are noted against them in Table II.

TABLE II

Treatment	Temperature of hot water	Duration	Percentage of germination
Hot Water	60 to 70° C.	One hour	26
	70 to 80° C.	do.	32
	80 to 90° C.	do.	52
	90 to 100° C.	Half an hour	75
Conc. Sulphuric Acid		5 minutes	18
		10 „	24
		15 „	35
		20 „	56

The hot water treatment (90 to 100° C.) for ½ hour and the treatment with concentrated sulphuric acid (20 minutes duration) were found to be best of all treatments with 75% and 56% germination respectively.

DISCUSSION

Despite the good results produced by application of sulphuric acid treatments and scarification, certain defects like breaking of seeds into bits when they are rubbed a little heavily which results in the loss of good amount of germinable seed and handling difficulty of sulphuric acid by unskilled farmer besides his disability to fetch the same easily, deter the wide application of these two methods in practice. The hot water treatment besides its effectiveness is most simple and practicable and the advantage of the method can be taken of to achieve the object. The required amount of seeds are tied in a piece of cloth or a gunny bag, preferably in the latter and dipped in near about boiling water for 15 to 20 minutes and then sown in the field.

ACKNOWLEDGEMENT

Our thanks are due to Sri. B. Venkoba Rao, Principal, Agricultural College, Hebbal, for the encouragement and facilities given by him during the course of these investigations.

REFERENCES

1. ANONYMOUS (1958), "Green Manure crops for Cocoanut plantations," *Cocoanut Bull.*, **11** (10) 357–67.
2. ARAKERI, H. R. (1955), "Hard seeds in Guwar," *Farmer*, **6** (38).

(Received: 26th June 1958)

EFFECT OF SPACING-*CUM*-NITROGEN APPLICATION ON THE YIELD OF SUGARCANE IN MALNAD TRACT

By S. V. Patil,[1] M. B. Tippannavar[2] and M. V. Kulkarni[3]

Introduction

Sugarcane is an important irrigated crop in Mysore State. It is grown over an area of about 1,11,500 acres. There are four major zones where sugarcane is grown on a large-scale, *viz.* (*a*) Belgaum area under Lift irrigation and Ghataprabha Canal, (*b*) Mandya area under Visvesvaraya Canal, (*c*) Raichur and Bellary area, under Tungabhadra Project and (*d*) Malnad area with irrigation from wells, tanks and *bhandaras*. In Malnad tract, sugarcane is grown in paddy plots in rotation with paddy. The planting is generally done in February and only one to four irrigations are given. In April and May pre-monsoon showers are received and South-West monsoon rains start from June onwards. Therefore during this first two to three months only, irrigations are required to be given to the crop. As such, the cost of cultivation is very much low and there is considerable scope to increase the area under sugarcane in this tract. At present, however, the yield of sugarcane in the Malnad tract is low with yields averaging from 15 to 20 tons per acre, due to unsuitable cultural practices like close spacing, lack of fertilisers, etc. With a view to determine the optimum spacing and fertiliser requirements, investigations were carried out at the Agricultural College Farm, Dharwar, and some of the details of the same are presented in this paper.

Review of Literature

Arakeri (1956) summarising the research work carried out at the Sugarcane Research Station, Padegaon, reported that a spacing of 3½ to 4′ and application of 300 lb. of nitrogen is advantageous in getting higher yields for January planted sugarcane crop. The spacing and manurial experiments conducted at Anakapalle and Samalkota in Andhra State (*Memoirs*, Department of Agriculture, Madras, 1954) have indicated that 2′ 8″ is the advantageous spacing and nitrogen varying from 100 to 250 lb. per acre as the optimum dose depending upon the tract and initial soil fertility for getting higher yield of cane. At Kolhapur in Bombay State (*Annual Report, Sugarcane Research Scheme*, Padegaon, 1956) results have revealed 4′ spacing has given

[1, 2, 3] Agronomy Section, College of Agriculture, Dharwar.

significantly higher yields than 3′ spacing and that the response to nitrogen was linear, with 300 lb. nitrogen giving higher yield than 150 and 225 lb. nitrogen per acre. In the experiments conducted at Alnavar, in North Kanara District (Malnad tract), with applications of 150, 225 and 300 lb. of nitrogen per acre (*Annual Reports*, 1955 and 1956) application of 300 lb. have given about 15 and 7 per cent. higher yields than 150 and 225 lb. respectively.

Materials and Methods

The experiment consisting of three spacings (2, 3 and 4′) and two levels of nitrogen (150 and 225 lb. N/acre) was started in the year 1955–56 and continued for three years. The layout followed was split plot design with spacings as main treatments. There were in all four replications. The experiment was laid out in paddy lands situated along the *nala*. The site of the experiment was changed every year. The type of soil was alluvial. Basal dose of 20 cartloads of F.Y.M. was applied before planting and 100 lb. of P_2O_5 was applied in the form of single superphosphate in two equal doses; one at planting and the other at the time of earthing up. The nitrogen was applied in the form of ammonium sulphate and groundnut cake in 1 : 2 proportion and in four doses. The planting of cane was done in February and variety used was CO 419. The harvesting of crop was done in the succeeding January or February. The number of irrigations given were 3 to 4 per year. The planting was done with 3 eye-budded sets with sets overlapping by 1 to 2″.

Results

Yield.—The yields of cane obtained for different treatments are given in Table I.

There has been significant difference between the levels of nitrogen in only two years. The application of 225 lb. of nitrogen has helped to increase the yield of cane by about 10 to 20 per cent. over 150 lb. nitrogen application. There is no significant difference between the different spacings in any of the years. However, it is indicated that when the yield is about 20 to 35 tons per acre, a spacing of 2′ is conducive for higher yields, whereas when the yield is about 35 to 55 tons per acre, 3′ spacing is essential. The interaction between nitrogen application and spacing is significant only for 1957–58 crop. With 3 and 4′ spacings, there is significant response to the application of higher levels of nitrogen, while there is no such response with 2′ spacing. The higher level of nitrogen has given significantly higher yield in case of 3′ spacing as compared to 4′ spacing. Although there is no significant difference between 2 and 3′ spacings, the trend is that the yield tends to be high with 3′ spacing than with 2′ spacing.

TABLE I

*Effect of spacing-*cum*-nitrogen application on the yield of sugarcane* (1955–58) *at the College of Agriculture, Dharwar*

Spacing	1955–56		1956–57		1957–58		Average of 3 years	
	150 lb. N	225 lb. N	150 lb. N	225 lb. N	150 lb. N	225 lb. N	150 lb. N	225 lb. N
	Tons/acre							
2′	31·0	35·5	21·2	24·0	49·5	49·2	33·9	36·2
3′	28·5	32·0	20·6	18·5	44·7	54·1	31·2	34·8
4′	23·5	30·0	19·0	17·6	36·1	44·8	26·2	30·8
Average ..	27·6	32·5	20·2	20·0	43·4	49·3		
C.D. at 5% for N levels ..	1·37	Not significant			3·57			
C.D. at 5% for comparing different levels of N at fixed spacings ..	Interaction not significant				6·2			
C.D. at 5% for comparing different spacings at the fixed level of N	do.				5·8			

Plant Population, Height and Girth.—The observations regarding number of canes produced, height and girth of the cane taken for 1957–58 crop are summarised in Table II.

TABLE II

*Effect of spacing-*cum*-nitrogen application on the plant population, height and girth of cane* (1957–58)

Spacing	Rate of N application per acre (lb.)	No. of millable canes/acre	Height of dressed cane	Girth of dressed cane (at the centre)
2′	150	37,762	8′–3″	3·7″
2′	225	39,009	8′–0″	3·7″
3′	150	32,489	7′–8″	3·6″
3′	225	38,669	7′–11″	3·8″
4′	150	29,994	7′–7″	3·4″
4′	225	32,035	7′–8″	3·4″

The number of millable canes produced per acre has increased with application of higher levels of nitrogen. The increase is more marked in case of 3′ spacing than with other spacings. In case of 4′ spacing, the number of canes produced is less by about 20 per cent. as compared to canes produced with 2′ spacing. The height and girth of canes is less with 4′ spacing as compared to 2 and 3′ spacings.

Discussion

With application of 225 lb. of nitrogen per acre the yield of sugarcane has increased by about 5 to 10 tons per acre as compared to 150 lb. nitrogen application. This indicates that the application of higher dose of nitrogen is necessary for increasing the yields of cane as nitrogen application results in increasing the number of millable canes produced per acre and thus reflecting an increase in yield. Dillewijn (1952) states that in Java, where the cane is harvested when it is about 14 months old, increasing applications of nitrogen result in increased number of millable canes, till a maximum is reached, beyond which additional nitrogen dose gives no further increase in number of millable canes. Mohan Rao and Narasimhan (1956) in Andhra State have observed in their studies that increased number of millable canes result with increase in the nitrogen application from 100 to 150 lb. per acre. With the application of 200 lb. nitrogen however, decreases in number of millable cane is observed. In the present investigation, higher yields of cane has been obtained with 225 lb. nitrogen as compared to 150 lb. Therefore, it may be necessary to include higher levels of nitrogen in future trials to fix up an optimum level for this tract.

When the average yields are low (20 to 35 tons per acre) 2′ spacing has given higher yields. However, when the average yield is in the order of 35 to 55 tons per acre, 3′ spacing is necessary. With 2′ spacing, the total planted row is more and as such the number of millable canes tends to be more. In case of 3′ spacing and 225 lb. nitrogen application the plant population as well as the girth of the canes tends to be more and thus results in higher yields. This indicates that when the land is fertile and when adequate quantity of manure is applied, 3′ spacing is more advantageous in getting higher yields of cane. From the point of convenience in intercultivation operations and earthing up by bullock-drawn implements also, 3′ spacing is however more suitable than 2′ spacing.

Summary and Conclusions

An experiment with 2, 3 and 4′ spacing and 150 and 225 lb. of nitrogen per acre was conducted in the paddy lands at the Agricultural College Farm, Dharwar, for three years. Increased yield of cane to

the extent of about 5 to 10 tons per acre was obtained with application of 225 lb. of nitrogen as compared to 150 lb. nitrogen. For the sake of convenience in using bullock-drawn implements for intercultivation operations and earthing up, 3′ spacing appaears to be suitable for sugarcane cultivation under *Malnad* conditions.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. H. R. Arakeri and Shri D. V. Murthy for their help in revising the paper and for helpful suggestions.

REFERENCES

1. ANONYMOUS (1954), *Memoirs of Department of Agriculture, Madras*, 425–80.
2. ——— (1955), *Annual Report of Sugarcane Research Scheme*, Padagaon, 1954–55, 127–28.
3. ——— (1956), *Ibid.*, 1955-56, 134–37.
4. ARAKERI, H. R. (1956), *Present Position of Sugarcane Research and Development in Bombay State*, Department of Agriculture, Bombay, 23–24.
5. DILLEWIGN, C. VAN. (1952), *Botany of Sugarcane*, The Chronica Botanica Co., U.S.A.
6. MOHANA RAO, N. V. AND NARASIMHAM, R. L. (1956), *Some Aspects of Nitrogen Nutrition to Sugarcane in Andhra (India)*, *Proc. I.S.S.C.T.* 9th Congress (New Delhi), 74–94.

(Received: 2nd July 1958)

THE HAIRY CATERPILLAR PEST OF CARDAMOM

By S. V. Rajan*

Introduction

Cardamom (*Eletteria cardamon*) is one of the best known spices which is grown extensively in the mountainous regions of South-West India and Ceylon. India holds monopoly in the supply of this valuable spice, in the world market; and it is an important dollar-earning agricultural produce. In the New Mysore State, cardamom is grown extensively on the hilly slopes of Malnad Districts of North Canara, Chickmagalur, Hassan and Coorg. In Mysore State nearly 40,000 acres are under cardamom cultivation and Mysore State is second in the production of cardamom in the entire Indian Union. Further, the variety of cardamom grown in Mysore is known to be of a better quality, preferred to that of other varieties grown elsewhere in India.

It is quite natural that the protection of such a valuable crop is of great importance. This crop is known to be attacked by several insect pests, *viz.*, the thrips—*Tæniothrips cardamoni* Ramakrishna Ayyar; the Stem-borer—*Dichocrocis punctiferalis*, Guenee; a fly stem-borer; a *Scolytid* beetle pod-borer; and the hairly caterpillar *Eupterote canaraica.*

Of these insect pests, the thrips and the hairy caterpillar are two very serious pests in cardamom plantations. Thrips, when virulent, can cause 30–60% loss to the crop. The leaf-eating hairy caterpillar appears in an epidemic form in a cyclic sequence of 8–16 years and causes considerable damage to the crop, by completely defoliating the plantations. Of late, this last-named pest seemed to have changed its original periodicity of 15–16 years to that of 8–9 years.

The Divisions of Entomology in Mysore and Madras States have been studying and have contributed much to our knowledge of these pests, regarding their life-history and different control measures (Puttarudriah, 1955 and Abraham, 1955).

A Brief Historical Note on the Hairy Caterpillar (*Eupterote canaraica*)

This pest was believed to be a pest of minor importance, occurring periodically once in 15–16 years, and spread over a period of 3–4 years,

* Research Assistant in Entomology, Coorg.

causing extensive damage to cardamom crop, and thereafter gradually declining in intensity and virulence. The pest was reported in 1922 in the Manjarabad Taluka of Hassan District. Again in 1937–38, it broke out in an epidemic form in Bababudans of the Chickmagalur District, and in Coorg District also. The pest was reported again in 1945 and 1953 for the third and fourth times in Mysore State. In Coorg, the pest appeared thrice as serious pest between the years 1944–54, destroying many of the best cardamom gardens, even though the same were free from Mosaic disease or *Katte*. Another interesting feature about the outbreak is that the pest breaks out in a discontinuous manner in several estates, and its virulence varies from block to block, in the same estate. This may be due to several ecological and biological factors. The outbreak of 1953–54 was the worst one both in old Mysore and Coorg area, for its virulence and extent of damage.

Life-History and Bionomics

The hairy caterpillars are the larval forms of an eupterotid moth, brownish yellow in colour with two dark diagonal bands and zig-zag lines on the wings. The wing expanse measures nearly 4 inches. The female moth is bigger in size with filiform antennæ, large abdomen and fine hairs all over the body. The male is smaller in size with plumose antennæ and small tapering abdomen. The moths emerge from pupæ in the months of June-August, after the advent of South-West Monsoon showers and begin egg-laying on the leaves of many varieties of shade trees in the evergreen forests of Malnad. Eggs are laid in close clusters of 100–130 eggs, on the ventral side of the leaves. The eggs are sub-spherical in shape and pale yellowish green in colour. The eggs are of mustard seed size. Eggs hatch after 8–12 days of incubation, into small black caterpillars of 3 mm. in length. The young caterpillars are gregarious in habit and feed on the leaves of shade trees. After feeding, the colour of the caterpillars change gradually into greyish green. After feeding and finishing one leaf, the whole group of caterpillars migrate to another leaf on the same branch. The caterpillars move in pairs, one behind the other in a regular procession, during such migration from leaf to leaf. After 10–12 days, the caterpillars moult for the first time, and feed voraciously. During the 2nd instar stage, the colour changes to pale green, with two prominent black spots appearing on each segment. Size increases to 8 mm. in length, during the 2nd instar stage. Hairs are prominently visible on each segment. During the 3rd instar stage, a few yellow patches and an yellow band in the mid-dorsal line appears. After the 4th instar the colour once again changes to blackish grey, and finally turns into black. It has been observed that the caterpillars moult 4–5 times, with a rather prolonged larval period approximating to nearly

132 days. The pupation is not uniform and well demarcated and is spread over a period of 20–30 days.

In nature, the caterpillars exhibit several colour phases. Some are black with whitish grey hairs; some are ash-coloured with reddish brown patches and long white hairs; some are greenish grey with prominent yellow band in the mid-dorsal line with black spots and grey hairs; some are black with reddish yellow stripes and red patches. A fully grown caterpillar measures 3–4 inches in length, with tufts of long hairs all over the body. The hairs are very irritating when touched and cause blisters on the skin. After 2nd moulting the caterpillars descend down shade trees by means of fine silken threads and feed on cardamom plants. The fully grown caterpillars congregate in hundreds on the bases of the tree trunks, crevices and shady side of branches during daytime. They are nocturnal in habit, and feed voraciously on the cardamom leaves at nights. Masses of black pellets of their excreta accumulates near the resting place, which is a sure indication of the congregating caterpillars.

The fully grown, mature caterpillars begin to pupate towards the end of December and pupation will be completed by the end of February. The caterpillars pupate at the bases of shade trees, underneath dried leaves and logs, decaying leaves, debris and loose soil. Sometimes the caterpillars pupate among the dried folded leaves of cardamom plants and other neighbouring plants also. The pupæ are also sometimes found inside the loosely woven covering of dried leaves, castings and pellets of excreta and other debris. The pupæ are dark brown in colour and measures 1 to $1\frac{1}{2}$ inches in length. In nature, the pupal period extends over a period of 7–8 months, till the break of the next monsoon season. The moths emerge in June-July after the monsoon showers and soon begin egg-laying in August-September.

At present, the studies made so far reveal that there is only one generation a year; it remains to be seen whether the different colour phases, seen in caterpillars, are due to metabolic changes or whether they represent different varieties or sub-species of one and the same species. These points are presently under study and investigation.

Control Measures

The pest can be effectively controlled by adopting the following methods:—

1. *Hand Picking.*—The congregating caterpillars can be easily destroyed by disturbing one or two in the midst of congregation, when all of them drop down *enmasse* automatically. Such caterpillars may be

made to drop into a basin or tinful of kerosened water and killed. Large masses of caterpillars can be destroyed by burning. This is the most common method of control adopted by planters.

2. *Control by Insecticides.*—Several insecticides have been found effective, of which the following are the most important ones:—

(*a*) *Honge Oil Rosin Soap and Fish Oil Rosin Soap.*—1 lb. in 10 gallons of water, when sprayed on the groups of congregating caterpillars, have proved effective and account for cent. per cent. mortality of the caterpillars in 24 hours. These are cheap, and effective contact poisons, without any residual effect.

(*b*) *D.D.T.* 50% *W.P.*—1 lb. in 16 gallons of water proved to be a very effective and popular insecticide both as contact and as stomach poisons, during 1953–54 trials in Mysore. Planters in Coorg have however found that 1 lb. in 10 gallons of water gives rather surer results in controlling the pest.

(*c*) *Geigy* 1250.—A wettable powder containing D.D.T. and B.H.C. in balanced proportions also gives good results.

(*d*) *Parathion* 0·025% *or Ekatox* 20.—1 oz. in 5 gallons of water can also be effectively used against the pest. The caterpillars are paralysed and killed in about 24–36 hours. Further the residual effect of the insecticide lasts for a week.

(*e*) *Folidol,—E* 605.—A new powerful phosphoric ester, containing 46·6% "Parathion" and special emulsifier manufactured by Messrs. Bayer & Co., when sprayed at 0·1% concentration, has been found to paralyse the caterpillars in 5–6 hours and kill them in about 24 hours. These Parathion compounds act as contact, stomach and respiratory poisons and this factor is responsible for their effectiveness as insecticides of great importance. The use of such insecticides require careful handling under proper supervision to avoid human toxicity hazards. These should not be smelt nor split on the skin.

3. *Destruction of Pupæ.*—The most effective and cheapest measure of control is to collect and destroy the pupæ. From January onwards, during their leisure or spare-time, the planters can get the pupæ collected at the bases of shade trees, underneath the fallen logs of wood, and dried leaves and burn them. By far this is the easiest and the cheapest method of control that could be undertaken by planters of limited means.

4. *Biological Control.*—In several estates, a white entomogenous fungus, probably *Beauveri bassiana*, has been found to attack the caterpillars and pupæ, and kill them. Advantage can be taken to collect such fungus infested caterpillars and distribute them in places where it is not found.

Two unidentified parasitic flies, one dipterous and another hymenopterous, are found parasitising the caterpillars. But their incidence is not high to be of practical use.

A predatory bird, also unidentified, is noted to prey upon the caterpillars.

These natural enemies are found to exert some effective control in keeping the population of the pest under control. A thorough and detailed study of their life-history and habits is being made.

By adopting and following the above measures of control in time, the cardamom planters can effectively control this important pest.

ACKNOWLEDGEMENT

The author is grateful to Drs. M. Puttarudriah and P. Abraham, from whose published work much use has been made of in the writing up of this article.

REFERENCES

1. ABRAHAM, P. (1955) "New better possibilities with cardamom," *Indian Farming*, **5**, 9–14.

2. *Annual Progress Report of* 1957–58, Anti-hairy Caterpillar on Cardamom Scheme, Coorg.

3. PUTTARUDRIAH, M. (1955), "An epidemic outbreak of cardamom hairy caterpillar," *Indian Coffee*, **19**, 151–56.

(Received: 9th June 1958)

BRIEF NOTES ON RECENT INVESTIGATIONS ON SOME BENEFICIAL PARASITES IN MYSORE

By Dr. M. Puttarudriah[1] and S. Usman[2]

The investigations under the Biological Control Scheme envisage the possibilities of utilizing certain existing beneficial parasites for the control of some major pests of the more important crops like sugarcane, paddy, potato, cotton, etc. The following notes deal briefly with some of the recent investigations carried out.

I. Sugarcane

(1) Large-scale output of the rice moth, *Corcyra cephalonica* Stainton, for breeding the beneficial parasite, *Trichogramma minutum* Riley.—Mass rearing of *Trichogramma* for the control of the sugarcane shoot borer is undertaken in the Parasite Laboratory, Mandya, with *Corcyra* as the laboratory host. Jola (jowar) is used as food for the rice moth. Addition of yeast to jola has been found to improve the size of the rice moth and egg-production. Different food media, including the addition of certain vitamins, and optimum conditions of temperature and humidity are being investigated as factors for the population growth of this moth. The moth breeding chambers and collecting equipment are being standardized.

(2) Egg-parasites of the top borer.—*Tetrastichus schœnobii, Telenomus beneficiens* and *Trichogramma* sp. parasitise a large number of eggs of the top borer in nature and thus exert a great check on the pest population. At present the host egg-masses are being collected and the natural parasites that emerge are released back into the fields to conserve the parasites and build up their population. An easy breeding technique and a suitable alternate laboratory host for these parasites are under investigation.

(3) Tetrastichus ayyari Rohwer.—This has been found to be a pupal parasite of the top borer, besides parasitising other major lepidopterous pests of different crops. Its biology, host range and possibilities of utilization in the field have been investigated. Though easily bred in the laboratory on different hosts, it has been of doubtful success in the field.

---

[1], [2] Government Entomologist and Senior Assistant Entomologist, Biological Control Scheme, Department of Agriculture, Bangalore, respectively.

(4) Large numbers of natural parasites of the sugarcane mealybug, the leaf-hopper and the white-fly have been recorded for the first time in Mysore.

II. Paddy

(1) Egg parasites of the paddy stem-borer.—Three natural egg parasites, *viz.*, *Tetrastichus schœnobii*, *Telenomus beneficiens* and *Trichogramma* sp. have been encountered. Their status, seasonal incidence and biology have been worked out. It has been found that *Trichogramma* sp. can be bred on *Corcyra* eggs in the laboratory, and that therefore the possibility of its mass-multiplication and large-scale field release exists.

(2) **Larval parasite of the paddy gall-fly, *Pachydiplosis oryzæ*.**—The polyembryonic parasite, *Platygaster oryzæ*, has been obtained in large numbers on the grubs of this fly; particularly abundant in September-October. Further studies are in progress.

III. Jola

Studies on field releases of *Trichogramma evanescens minutum* Riley for the control of the jola stem-borer.—In three years' experiments conducted in Agricultural Research Station, Hagari, good colonization of *Trichogramma* was obtained after weekly parasite releases for 3 months as against its total absence in the check plots as well as in the bulk area, which is very significant although most unexpected for two reasons, *viz.* (i) the absence of the universal parasite could hardly be expected; and (ii) particularly so, when *Trichogramma* was released in the same area against the same pest during 1949–50 by the Madras authorities. The beneficial effect of the release was evident in the second month and it continued in the third month also; but during the fourth month this position was not maintained which can perhaps be explained by the low host density in that stage of the crop.

IV. Avare

***Microbracon hebetor* Say—Field releases against the Avare pod-borer.**—This parasite has been found successfully to parasitise the Avare pod-borer, *Adisura atkinsoni*, the other field hosts being the jola webbing caterpillar and the ragi stem-borer. It takes to *Corcyra* larvæ in the laboratory on which it could easily be multiplied on a large-scale. Though encouraging results were obtained in the trials of the early four years when the parasite was recovered in some numbers after the releases, no colonization of *M. hebetor* has been obtained since two years, whereas a sufficient number of the natural parasite *M. lefroyi* has been obtained. This negative result was further confirmed by the

pod infestation figures, which were practically the same for the parasite released and the control plots.

V. Cotton

(1) **Natural parasites of the cotton boll worms.**—In recent years the boll worm infestation has increased considerably in Mysore. *Microbracon lefroyi* is the most abundant larval parasite in nature. Attempts to rear this important parasite in the laboratory have not been successful so far. Though the parasites stung *Corcyra* larvæ, successful parasitisation was not obtained. Further investigations are in progress.

(2) ***Apanteles angaleti* Muesebeck.**—This parasite, which was newly discovered to parasitise the larvæ of the pink boll-worms in Delhi and which has since been sent to U.S.A. for colonisation purposes, has been found to occur in Mysore. A culture of this parasite on young *Corcyra* larvæ is being maintained for undertaking field release trials.

(3) ***Trichogramma minutum* Riley** was found successfully to parasitise the eggs of the spotted boll worms both in the laboratory and in small-scale outdoor tests. Large-scale field trials with this parasite are being contemplated.

VI. Potato

(1) **Parasites of *Epilachna*—***Epilachna* sp. feeds and skeletonises the leaves of potato, brinjal, etc. Investigations during the recent years showed for the first time the existence of a complex of at least seven species of parasites with *Pleurotropis foveolatus*, *P. epilachnæ* and *Tetrastichus* sp. in the primary role, *Tetrastichus* sp., *Pleurotropis* sp., *Aximopsis* sp. and *Eupelmus urozonus* as secondary parasites. Except *P. foveolatus* all other parasites are new records.

Since previous year's field release trials with *P. foveolatus* had shown a marked increase in colonisation of the parasite in the released plots as compared to the natural parasitisation in the control plots, studies have been initiated to observe the trends in the development of the populations of the host and parasites both under natural conditions and after releases. The most favourable time for the releases, as also the number of parasites to be released per unit of area, are being investigated. An easy and effective technique for mass breeding of the parasites in the laboratory is being evolved.

(2) **Potato Tuberworm.**—*Neochelonella* sp. nr. *curvimaculata*, *Dioctes* sp., *Campoplex* sp., an unidentified Ichneumonid and the parasitic nematode, *Hexamermis* sp., were taken for the first time as the natural larval parasites of the potato tuberworm. This is the first

record of the parasites of the potato tuberworm in India, whereas no less than 42 parasites have been reported from other countries.

It will be evident from the foregoing account that very useful work has been done with promising results. In order that these results may become of practical application and material benefit to the agriculturists, further investigatons are in progress.

(Received: 27th June 1958)

AN UNUSUAL MODE OF FEEDING BY *EPILACHNA SPARSA* H. (COCCINELLIDAE : COLEOPTERA) ON BRINJAL (*SOLANUM MELONGENA* L.)

By D. V. Murthy*

During investigations on the insect pests of brinjal round about Bangalore, the writer came across an interesting type of attack by *Epilachna sparsa* H. The crop of brinjal had been planted during second fortnight of December 1957 and at the time of visit (10–3–1958) was in flowers and fruiting. Almost the entire leaves were found completely skeletonised in the characteristic feeding fashion of *Epilachna*. Except for a few stray adult beetles, the insect was found mostly in late larval instars.

A number of newly formed brinjal fruits and flowers were found with irregular patches on the surface. A closer examination revealed this to be due to feeding by *Epilachna* grubs and characteristic feeding patches could be made out on many fruits in a few cases accompanied by grubs. Figures 1 and 2 show such feeding symptoms on some of the fruits. A random evaluation of the infestation showed that nearly 50% of the fruits were found with the symptoms of attack.

A large collection of both sound and damaged fruits was made to study the effects of storage of these fruits. While the sound fruits could be kept safely for nearly 10 days at a stretch most of the affected fruits were found to turn black and wither up or rot within a period of 4–6 days depending perhaps upon the age of fruits and intensity of attack.

A probable explanation of this unusual mode of feeding might be due to the unavailability of green brinjal leaves for feeding by the grubs and also due to non-availability of other alternate host plants round about.

* Senior Assistant Entomologist, Department of Agriculture, Bangalore.

(Received: 10th April 1958)

FIG. 1

FIG. 2

FIGS. 1 & 2. Damage caused by *Epilachna* to Brinjal fruits

A NOTE ON SIMULTANEOUS GREEN MANURING IN THE STANDING CROP OF DRILLED PADDY

By S. V. Patil[1] and M. V. Kulkarni[2]

Introduction

Green manuring of crops presents a number of practical problems. In *Malnad* tract of Northern Mysore where paddy is an important food crop it is difficult to obtain enough quantity of organic matter to incorporate into the soil. To take recourse to green manuring in the normal way is also not possible. The paddy crop is drill-sown towards the end of May or beginning of June and harvested in November and is entirely rainfed. As practically no rains are received in the area after November, it is not possible to raise any green manure crop in the fields. There are also difficulties in obtaining green matter from elsewhere as is done in southern parts of Mysore.

Arakeri and Patil (1957) in their studies on green manuring have advocated the growing of green manure crops along with the main crop whenever the latter are sown in broadly spaced rows. With a view to find out whether such a method is feasible in the above case where paddy is drilled in rows 12″ apart or broadcast sown sometimes, trials were carried out in the Agronomy Section of the College of Agriculture, Dharwar, and the following method has been tentatively evolved.

Method

About 1 to 2 lb. of *Sann* seeds are mixed with 40 lb. of paddy seed and sown together on an acre of land by end of May or beginning of June, which is the usual time for sowing paddy in the *Malnad* tract. *Sann* seeds germinate along with paddy and their growth is also faster. Heavy and continuous rains usually start from July onwards. The *Sann* sown along with paddy by this time would be of about 2 to 3′ in height and paddy 9 to 12″. At this time water is impounded in the field and *Hodatha* operation is carried out. This operation is done by dragging on the crop a wooden plank called *Doni* with a man standing on it. This may cause slight injury to the stems of paddy, which however stimulates tillering. Further, the dicotyledonous and other young

[1, 2] Section of Agronomy, College of Agriculture, Dharwar.

weeds are effectively smothered by this operation. During this operation alone, the *Sann* plants get broken and buried in the mud. It has been observed that when about 2 lb. of *Sann* seed is sown, about 2,000 lb. of green material is obtained in this method and growing of *Sann* in this way for green manure purpose does not affect the young paddy crop but on the other hand helps to incorporate about 2,000 lb. of green material in the soil. A dose of top dressing given a few days after *Hodatha* operation will help in quick rotting of the buried material and better growth of the standing paddy crop. A total dosage of about 30 to 40 lb. of nitrogen and 30 to 50 lb. of phosphoric acid per acre, could be applied to paddy. Nitrogen is applied in three equal doses, one at sowing, second a few days after *Hodatha* operation and the last a few days before flowering. The phosphoric acid could be however applied all in one dose at sowing mixed with farm-yard manure. The combination of fertilizer application and *Sann* green manuring helps to increase the yield of the crop.

Conclusions

With the method described above green manuring with *Sann* can be done without affecting the paddy crop or without interference with other seasonal operations. The method is simple and can be conveniently followed with a small extra cost expended on green manure seed only. On the Agricultural College Farm, Dharwar, this method of green manuring is being followed on a large scale on an area of about 60 acres. Further work whether the seed rate of *Sann* could be increased without affecting the paddy crop is in progress.

References

1. Arakeri, H. R. and Patil, S. V. (1957), "The why and how of green manuring," *Indian Farming*, **7** (1), 24–27.

(Received: 18th June 1958)

General, Review and Extension Articles

A NOTE ON COTTON CULTIVATION IN BELLARY DISTRICT

By G. N. Alasingarachar*

Introduction

The total area under cotton crop in New Mysore State is about 28 lakhs of acres yielding an average production of 4½ lakhs of bales. Bellary District situated in the northern part occupies 2½ lakhs of acres; producing an average production of 50 thousand bales of lint per annum, *i.e.*, 11·1% of the total lint production in the State.

The seasonwise distribution of Cotton crop cultivation in Bellary District is as follows:—

(*a*) *Mungari* season	..	75,000 acres
(*b*) Early *Hingari* season	..	50,000 ,,
(*c*) Late *Hingari* season	..	1,25,000 ,,
Total	..	2,50,000 ,,

Soils

Soils of this district are varied in origin. These soils are deep red, light red, red mixed black, medium black and deep black. *Mungari* Cotton crop is grown in light red soils, deep red soils and red mixed black soils.

Early *Hingar* Cotton crop, *i.e.*, *Laxmi* grown in medium black soils and late *Hingar* crop, *i.e.*, *H.* 1 is generally grown in deep black soils.

Rainfall

Annual average precipitation comes to about 24 inches with a distribution as follows:—

Period		Rainfall in inches
(*a*) South-West monsoon	..	14
(*b*) North-East monsoon	..	7
(*c*) Summer rains ..	..	3
Total	..	24

* District Agricultural Officer, Bellary.

Cotton Zones and Improvements

The rainfall and soil types vary from taluk to taluk in this district. Therefore area under different varieties of cotton also varies from area to area. But all the three types of cotton, namely, *Arboreums*, *Herbaceums* and *Hirsutums* are grown in this district.

During *Mungari* season, about 75,000 acres of *Bokada* variety is grown mostly in Bellary and Siruguppa Taluks and small areas in other taluks. This is a very coarse variety having a staple length of $\frac{1}{2}''$ yielding about an average yield of 10 maunds of kapas per acre. For want of suitable improved strain to replace the above local variety, hitherto, it was being allowed to be grown in this district. For the past three years, an improved strain of H. 420 got from Madhya Pradesh is being introduced in this district to replace *Bokada*. This improved variety has gained popularity amongst ryots due to its fine quality of lint having a staple length of 13/16″ and an extra yielding of about 5 maunds of kapas per acre over *Bokada*. For want of enough quantity of seed material of this improved variety to saturate the entire area, *Bokada* is yet occupying 75% of *Mungari* cotton area. For the past three years, the H. 420 seed produced on the Agricultural Research Station, Hagari, is being multiplied on farmers' fields in Kudathini Village for further distribution in the district by the Department. Within a period of 2 to 3 years, the entire *Mungari* cotton area would be saturated with H. 420. Thus, the *Mungari* cotton production of 15,000 bales of coarse and short staple lint will be replaced by 18,500 bales of H. 420 Cotton lint having a fine quantity and medium staple length of 13/16″ getting an additional production of 3,500 bales and accruing an additional income of Rs. 8·5 lakhs to the cultivators of this district.

Early Hingari

During this season mostly *Laxmi* cotton is sown in this district. For want of a Cotton Breeding Station in this district and suitable Co-operative Cotton Sales Societies for the purchase of kapas from the ryots and arranging distribution of seeds, the earliest generation seeds is procured from Gadag to an extent of 2,000 maunds every year to introduce earlier generation seed in this area. The area under *Laxmi* cotton crop is about 50,000 acres, producing about 8,300 bales of medium staple length cotton. The necessity of one Cotton Breeding Station is keenly felt in this district for multiplication of this variety as well as a few good societies to purchase the kapas from the ryots and to take up the distribution of seeds during sowing season.

H. 1.—This variety is generally grown during late *Hingari* season in this district. This is a medium staple cotton having a staple length

of 13/16″ occupying an area of 1,25,000 acres and producing an average yield of 15,000 bales of lint. This variety is grown free from mixtures. The earliest generation seed procured from Agricultural Research Station, Hagari, is being distributed in Joladarasi Village for multiplication and further distribution among farmers.

Irrigation

The area under irrigated cotton in Bellary District is about 2,000 acres chiefly grown in T. B. P. *Ayacut* in Hospet, Siruguppa and Bellary Taluks. The variety grown is *Laxmi* which is adoptable to irrigated condition. Sowings of irrigated cotton is done during August and September and picking is done from February to April. It is generally grown as a pure crop. It is expected that the area under irrigated medium staple cotton will be on the increase during the coming years with the further development of the T. B. P. *Ayacut*. The crop is susceptible to the attack by pests and diseases under irrigated condition.

Experiments are on hand in Siruguppa Farm to find out suitable variety of long staple cotton which can also withstand attack by pests and diseases under irrigated conditions.

Manuring

In dry lands only farm-yard manures are applied at 10 to 15 cartloads per acre once in 3 or 4 years. The following are the dosages recommended for dry and irrigated cotton in the district.

Variety	Rainfed	Irrigated
Ammonium sulphate ..	100 lb.	150 lb.
Superphosphate ..	75 ,,	150 ,,
Muriate of potash ..	25 ,,	60 ,,

75 lb. of ammonium sulphate, 150 lb. of superphosphate and 60 lb. of muriate of potash may be mixed and applied in furrows at a uniform depth of 3 to 4 inches just before sowing and at the time of flowering, *i.e.*, 10 weeks after sowing, 75 lb. of ammonium sulphate is given as side dressing.

For rainfed cotton, the entire dose recommended is applied in furrows at the time of sowing.

Pests and Diseases

Generally *Arboreum* and *Herbaceum* types of cotton in the district are free from pests and diseases. But during seasons of excessive rainfall, these types are also susceptible to wilt and boll-worms. *Hirsutum* types of cotton are very easily susceptible to pests and diseases. Disinfecting cotton seed with *Ceresan* at the rate of 4 oz. for 60 lb. of seed is recommended to prevent Black-arm and other seed-borne diseases.

Dusting of B.H.C. 5% or 10% and spraying 50% B.H.C. and 0·02% Folidol is recommended against pests, *viz.*, Boll-worm, Leaf roller, Aphids, Jassids and Thrips.

There is scope for improvement of yield of cotton and securing better prices to the farmers if careful zonalisation of areas for specific varieties and organisation of Cotton Sale Co-operative Societies is taken up.

(Received: 10th July 1958)

IMPROVED AGRICULTURAL PRACTICES AS AN AID TO BETTER FARMING IN TUNGABHADRA PROJECT AREA

By Ali Hyder[1] and H. Purnapragnachar[2]

Introduction

The then districts of Rayalaseema of composite Madras State comprising of Bellary, Cuddapah, Kurnool and Anantapur were often striken by famine due to frequent failures of rainfall and consequent failure of crops. They were typically classified as "Famine Zone". The only solution to the problem of ameliorating the conditions in these areas meant provision of artificial irrigation systems. Hence the waters of the Tungabhadra were harnessed to provide adequate water-supply for agricultural purposes and generate cheap hydro-electricity in this area.

There was a doubt as to the suitability of the black soils for cultivation under the irrigation waters of the Tungabhadra. It was felt whether alkalanity will develop due to irrigation as it had happened in irrigation systems of Punjab and Bombay States. The Agricultural Research Station, Siruguppa, was therefore started in 1937 to study (1) the Physico-Chemical reactions of deep and shallow black soils under light and heavily irrigated conditions and (2) to lay out Agronomical trials to determine the soil management requirements of different crops and to work out the economic details of such practices.

The findings of research carried out on this Agricultural Research Station so far reveal that no harmful effects will result by the use of waters of the Tungabhadra Project for irrigation. Besides, on the experiences and the results of research, a suitable cropping pattern has also been devised for adoption in this Project area. Various recommendations are given in the paras that follow.

Rotation of Crops

The following rotations are recommended for the three zones:—

A. *Perennial Zone.*–(1) Green Manure followed by Main Season Paddy (June to December) followed by Summer Paddy in one year and this is repeated year after year.

[1,2] Agronomist and Farm Manager respectively, Agricultural Research Station, Siruguppa.

(2) Two-year rotation of Sugarcane (March to February) followed by Green Manure (April-June) and Paddy (Main Season) (June to December) or

(3) Green Manure followed by Paddy (Main Season) followed by Summer Vegetables.

B. *Wet Zone.*—Only single crop Main Season Paddy (June to December) preceded by a Green Manure crop or a Late Season Paddy (September to October) preceded by a Green Manure crop.

C. *Dry*-cum-*Wet Zone.*—Cotton (*Hingari*)—Groundnut and Redgram (*Muugari*) Mixture, Jola (*Mungari*) (3-year Rotation) or Green Manure followed by Wheat (*Hingari*), Groundnut and Redgram Mixture (*Mungari*), Jola (*Mungari*) and Cotton (*Hingari*) (4-year rotation).

Use of Implements

The implements recommended for the Tungabhadra Project in wet or perennial zones are:—

(1) For preparatory ploughing in dry conditions: Victory Plough or Mysore Bar Point Plough.

(2) For Puddling in wet condition: P.S.G. 6 or Cooper 25. Puddler.

(3) For churning and making the soil soft: Wet Land Puddler (P.S.G.).

(4) For trampling Green Manure after spreading Green Manure: Green Manure Trampler.

In the dry-cum-*wet* Ayacut

(A) *For crops like Jola, Groundnut and Redgram, Navanai, Wheat, etc., which are to be grown in bed system of irrigation*:—

(1) For ploughing in dry conditions: Victory Plough or Mysore Bar Point Plough.

(2) For harrowing: Country Guntaka or HM 2 Guntaka or R.E. Guntaka.

(3) For putting bunds for beds to be formed: Bund Former.

(4) For opening channels at convenient intervals for irrigation: Ridger.

(5) For intercultivation for harrowing instead of the country *Janthulu.* H.M.O. Guntaka.

B. *For crops to be grown under the ridges and furrow systems of irrigation.*—The cultivation implements are the same as those in

the previous case except that for ridging the PSG ADJUSTABLE RIDGER is used and for intercultivation PSG ADJUSTABLE CULTIVATORS are used.

SEEDS AND SOWING

The following suitable strains for the Tungabhadra Project area are being recommended.

Crop	Strains recommended	Season of sowing
Paddy	APK. 2, GEB. 24	June–July Season
,, ...	ADT. 18, MTU. 15	September–October
,, ...	Co. 13	Summer Season (December-January)
Sugarcane	Co. 419	February–March
Jola	Co. 9 (*Mungari*)	June–July
,, ...	M. 31–2 (*Hingari*)	September—2nd week
Navanai	N. 1	June–July
Cotton	*Lakshmi*	August—2nd week
Groundnut ..	TMV. 2	June–July
Gaster	TMV. 2	do.
Gingelly	TMV. 2	do.
Red gram	*Udgir*	do.
Naked Wheat ..	NP. 710 or C. 253	October
Glumed Wheat ..	Strains are still under trial	do.
Bengalgram ..	No. 482	do.
Chillies	G. 1	July–August
Sweet Potato ..	IB. 24 or V. 2	do.

MANURES AND MANURING

Paddy.—5,000 lb. Green Manure or Green Manure grown *in situ* and ploughed in. Green Manure crop like *Sesbania*, which yields up to 18,000 lb. of green matter per acre, is recommended for single-crop wet lands. Over and above this a basal dressing of 40 lb. of P_2O_5 and 40 lb. N as top dressing is also recommended. Doses of 250 lb. of N are recommended for Sugarcane in the ratio of 1 : 1 inorganic and organic manures applied in two equal doses, *i.e.*, 1st dose 40 days

after planting cane and another dose at the time of earthing-up. This dosage is over a basal dressing of 5 tons of Farm-Yard Manure per acre.

In the dry-*cnm*-wet *ayacut*—40 lb. N in the form of Ammonium sulphate as top dressing is recommended for crops like Jola, Navanai, Wheat and Cotton at a basal dressing of 5 tons of Farm-Yard Manure. A dosage of 20 lb. P_2O_5 may also be applied as basal dressing with advantage.

A basal dressing of 10–15 cart loads of Farm-Yard Manure over basal dressing of 40 lb. P_2O_5 and top dressing of 40 lb. N is recommended for crops like Chillies, Garlic and Onions.

Irrigation

The irrigation systems in the wet and perennial zones are quite familiar, as these zones are fixed almost adjacent to the existing zones of old channel area of Kampli and Siruguppa and irrigation problems are not many to need any special attention. But the irrigation system in the dry-*cnm*-wet zone is quite new to the royts. Bed and furrow system irrigation are most suitable for irrigation and are also economical. For crops like Jola, Groundnut, Navanai, plot bed system of irrigation is recommended. The size of the bed should not exceed more than $\frac{1}{3}$ cent. If size of beds is bigger, uniform spread of water is not possible, thereby affecting the germination and subsequent growth. The beds are formed with the help of Bund Former which will on an average cover 6–8 acres per day. For crops like Chillies, Cotton, Vegetables, Maize, etc., the ridge and furrow system of irrigation is recommended. Depending on the crops, the spacing between the furrow will vary from 2–3′. The length of the furrows should be from 16–30′ depending on the slope. The ridges and furrows are opened with a P.S.G. Adjustable Ridger. For the intercultivation operations and for crops sown in bed systems H.M.O. Guntaka are advocated and for crops grown on ridges and furrows P.S.G. Adjustable Cultivators are recommended.

(Received: 2nd January 1958)

"COORG LIME"—A NEW VARIETY

By Dr. K. M. Aiyappa,[1] P. P. Nanjappa[2] and C. K. Subramanian[3]

Introduction

Everyone is familiar with *Nimbe Hannu* or lime or Kagzi lime—*Citrus aurantifolia* Swingle. Limes are rich in vitamins, minerals and alkaline salts and are used for flavouring dishes of vegetables, fish, meat, etc. Lime-juice is a delicious and refreshing beverage. Limes make good pickles and their rind gives a valuable flavouring material—lemon oil. Furthermore citric acid and calcium citrate are manufactured commercially from lime-juice. Lime-juice is also a cosmetic and is excellent for external application as a hair rinse, skin lotion or mouth wash.

New Variety

The common lime is a dense bushy tree full of thorns. Research has been going on at the Orange Research Station, Chethalli, since 5 years to isolate new citrus strains which have superior qualities. In this programme of citrus breeding numerous strains of lime are on adaptive trials and among these a strain of lime has now been isolated for its thornless nature. This strain has been named as "Coorg lime" and has no thorns on the tree. This quality makes it eminently suitable for commercial propagation. Thornlessness is a boon for the orchardists as this quality makes picking of fruits very easy. Normally, the ordinary lime is harvested by beating the bush with sticks with consequent damages to the bush as well as to the fruits, but in this thornless variety hand-picking can easily be done. Added to this, this new strain has more percentage of juice, less number of seeds and has a good size and various other qualities comparable to the ordinary lime as can be seen from Table I.

The tree grows to a height of 200 cm. with a spread of 350 cm. in six years, with spreading branches, wingless leaves, perfect flower single or in clusters, almost round fruits green to golden yellow in colour with thin peel and very slender and spindle-shaped juice sacs. It is a prolific bearer and the fruits can be harvested almost throughout the year, the peak season being June to October in Coorg. An individual tree has recorded an yield of 1,500 fruits per year, yielding commencing from the third year after planting.

1, 2, 3 Orange Research Station, Chethalli, Coorg.

TABLE I

Fruit characteristics	"Coorg-Lime" thornless variety	Lime—Ordinary, thorny variety
Weight	29·86 gm.	33·80 gm.
Volume	30·56 c.c.	32·55 c.c.
Diameter	3·76 cm.	3·82 cm.
Height	3·63 cm.	3·93 cm.
No. of seeds	2·00	9·55
Juice percentage	45·26	41·86
Acidity expressed as citric acid ..	9·59	8·96

HINTS ON CULTIVATION

This lime is propagated through seed layers or buddings. Freshly extracted seeds after partial drying in shade are sown on raised seed-beds. When the seedlings attain 3 to 6 leaves after about 2 months they are transplanted 9 inches apart in beds. Cultivation, manuring and frequent watering is carried out in the beds. After a year they are ready for transplanting in the fields in the next monsoon. Pits 2×2×2 feet are dug and filled with good top soil and compost and the seedlings are planted 15 feet apart. Manuring with 2 baskets of compost 8 oz. each of Ammonium sulphate and superphosphate per plant can be done in two doses before and after monsoon till the plant starts bearing. Afterwards the manurial doses are to be doubled. Removing of water shoots, dead twigs, etc., should be done regularly. Control of pests and diseases must be done rigidly.

It is hoped that the Agricultural Extension Officers of this State will give due publicity about this new variety to the orchardists in their areas. Plant material can be had from the Horticulturist, I.C.A.R., Citrus Research Station, Gonicoppal, Coorg.

(Received: 9th July 1958)

PROSPECTS OF RESEARCH AND DEVELOPMENT OF SPICES AND CASHEWNUTS IN INDIA

By Dr. K. M. Aiyappa*

Introduction

A glimpse into the early history of India reveals that the areas running along the Western Coast of Peninsular India, were considered the home for spices, which were exported to distant lands. Even to-day, India earns about 36 crores of rupees annually by exporting spices and cashewnut and the importance of spices and cashewnut in our economy, specially as foreign exchange earners is, therefore, well established.

Although spices have been known to occur in wild state in India from very early times, their commercial exploitation as plantation crop is largely the result of pioneering efforts by private enterprise. Introduction and systematic cultivation of spices such as cardamom, vanilla, pepper and cinnamon have been almost largely organised by private efforts.

The report of Spices Enquiry Committee, 1953, drew attention of all concerned to the potentiality of spices in earning foreign exchange and need to conduct systematic research in their cultivation and processing. Consequently a number of research stations on spices have been established, and for the first time, systematic researches are being initiated on different spices which will lead to tangible results in due course.

In recent years, the emphasis on cultivation of spices has increased, and among the field spices cumin, fenugreek, dill, anise, ajwan, caraway black, and black cumin are quite popular and common. The plantation spices are also gaining popularity and there is wide scope for extending areas under cardamom, cloves, cinnamon, camphor, assafœtida, pepper, nutmeg, vanilla, saffron, lemongrass, cocoa and cashewnut. Of the garden spices, ginger and turmeric are promising crops. Some sporadic attention has been paid on researches on some of these spices, but so far no systematic and well organised and vigorous research programme has been launched. It is however a matter of great satisfaction that such steps are being taken on hand.

---

* Horticulturist, Gonicoppal, Coorg.

Research and Development of Different Spices

Turmeric.—It is commercially grown in the States of Bengal, Andhra Pradesh, Madras, Kerala, Orissa, Mysore and Bombay. Researches at Konni in Orissa and Nagercoil has established that shading is helpful in turmeric cultivation. The most promising varieties are *Sarangada* and *Rudababathinga*, and the best spacing is found to be 9×9″. In curing of the Rhizomes, 'Madras'-method has been reported to be superior to 'local' and 'Bengal' methods. Manurial trials with phosphorus, potash and magnesium have not yielded conclusive results. About 120 different collections have been made at Peddalam. Regular manurial trials with N, P and K are necessary.

Ginger.—It is commercially cultivated in Kerala and Bengal. It has been established that reduction of seed rate below 1,000 lb. per acre reduces yields. Treatment with 0·1% mercuric chloride for 2 hours prior to storage reduces the storage loss due to soft rot.

Minor field spices.—Cytological investigations are in progress at Calcutta University with wild and cultivated *Mentha* spices, *Murrya gardenica*, *Clove*, *Accacia catechu.* Attempts are also being made to induce polyploidy by X-rays and colchicine treatments.

Pepper.—It is largely grown in Kerala and Mysore States and trials are under way to extend its cultivation to Assam, Orissa and other States. The earlier researches were initiated to find a remedy for *Pollu* or "hollow berry" disease. The vines respond to N, P, K fertilisation and application of ½ lb. of lime in alternate years is considered useful. The varietal trials laid out with a number of local varieties have not proved conclusive, but generally, the varieties collected from Travancore are found to give better yields than those from Malabar area. *Erythrina* standards have been found to be more suitable than others. A very promising hybrid has been obtained by crossing *Taliparamba I* with a wild type *Pepper atenuatum.* The hybrid is more vigorous and is a more precocious bearer. It was also observed that younger nodes produce roots earlier than older ones. In U.S.A. 88% success was obtained in propagating pepper by cuttings in frames. Similar studies under our conditions with synthetic growth substances should prove very useful.

In preliminary observational trials, some varieties, *e.g.*, *karimunda*, *kuthiravaly*, *arikottanadan*, and *chola* were found to bear only hermaphrodite flowers on spikes. This is a very desirable character. Hybrids raised by crossing are under trial. More recently it has been reported that DDT spraying has proved affective against *Pollu*, and also the attack is more severe in dense shade. It has been noticed that spike shedding is a varietal character and such plants should be used in

propagation. As a result of all these investigations, it is hoped that the pepper industry will be able to overcome some of its present difficulties.

Cardamom.—Kerala, Mysore and Madras form the major cardamom growing States in India. In addition to the four established varieties, *i.e.*, *Malabar*, *Mysore*, *Ceylon* and *Munjerabad*, fourteen promising types have been isolated for trial and breeding work is also in progress. It has been observed that fresh extracted seeds are better for germination and that scarified seeds germinate better. Small pandals for shading the seed-beds are found better than long pandal, or tree shades. Application of ammonium sulphate and superphosphate has provided some protection against clump rot, and thrips have been controlled by dusting gammaxene or spraying DDT emulsion.

Cashewnut.—It is cultivated in Kerala, Mysore, Madras and Orissa States and adaptive trials are in progress in Assam, Andhra and Bengal. Vegetative methods of its propagation have been standardised for multiplication of clonal progenies. Studies on its manurial and irrigational requirement and blossom biology are in progress. Cashew is a fairly hardy tree and responds well to manurial treatments. It should prove very paying on lands where nothing else is being grown at present.

Cloves.—Mysore and Madras States offer great prospects of extension of this crop where conditions for its growth are found ideal. The crop also offers an unlimited scope for research since practically nothing has been done so far.

Cinnamon.—It has been cultivated on a small-scale in Kerala, Mysore, Madras and Assam. It can be propagated by seeds as well as cuttings. Seeds collected from base are found to give better germination. Even self-sown seeds, which germinate under bigger trees, can be successfully transferred to nursery beds and subsequently utilised for planting.

Cocoa, nutmeg, vanilla.—These minor crops can be grown successfully in States of Southern Region, but no standardised practices have been evolved so far for their cultivation and propagation. If these spices are to be grown commercially in due course research work should be taken up on them at the earliest.

Lemongrass.—Although some acreage is to be found under lemongrass in Mysore, Kerala holds the monopoly for its commercial production. Manurial and varietal trials have been laid out in Kerala during recent years. Studies on blossom biology and determining the extent of cross-pollination under natural conditions are under way.

Assafœtida and Saffron.—At present they are grown only in Kashmir and they could be tried in other regions also for their commercial exploitation.

Camphor.—This promises a good market, but no attempts have been made to grow it as a commercial crop in India so far.

Conclusions

The foregoing review indicates that systematic and intensive research is very essential on spices. Our efforts in the past have been limited considered with the scope which spices offer in our country's economy. The need for a fully broad-based and intensive research programme is very clear.

It will be desirable that a few main stations with regional sub-stations, for individual spices or for several spices, should be organised with a broad programme embracing all aspects of culture of spices, *i.e.*, agronomy, plant pathology, entomology, plant physiology and soil chemistry. It will be desirable to have some staff for work on extraction and utilisation of essential oils from some of the spices.

The future programme should include the following aspects:—

1. Maintenance, standardisation and culture of important spices of scientific value.

2. Survey of spice growing areas with a view to select types and varieties suited for those tracts.

3. Crop improvement programme:

   (*a*) Selection of desirable clones and their multiplication.

   (*b*) Selection of high yielding bisexual forms.

   (*c*) Hybridization to combine desirable characters.

   (*d*) Studies on blossom biology and pollination and development of embryo.

   (*e*) Anatomical studies (including embryological and cytological investigations) with a view to detect linkage of desirable characters with morphological peculiarities if any.

   (*f*) Standardisation of propagation techniques:—

      (i) When seeds are used for propagation, their time of collection, sowing, germination and medium for germination and transplanting, etc., use of root-promoting growth substances at the time of transplanting the seedlings and similar studies.

(ii) Where vegetative propagation is used, type of material suitable for vegetative propagation, its age, evolving standard frames and use of growth substances should be investigated.

(*g*) Studies on rootstocks wherever considered necessary.

(*h*) Studies on nursery and plantation practices, including training, pruning, crop regulation, cover croping, green manuring and shading.

(*i*) In lemongrass, optimum time for cutting, interval between two cuttings and influence of cultural practices and manures on essential oil content and yield of oil.

(*j*) Cultural, manurial and spacing trials with ginger and turmeric and their effect on yield, quality and keeping quality of these spices.

(*k*) Processing, storage and marketing of the produce.

(*l*) Extraction, identification and full description of chemical and physical properties of essential oils extracted from spices and their utilization.

(*m*) Studies on crop pests and diseases.

(Received: 19th July 1958)

THE PRESENT POSITION OF WORK DONE ON FERTILISER REQUIREMENTS OF CROPS IN MYSORE STATE*

By S. S. Sirur**

For the formulation of fertiliser recommendations three essential things have to be considered, *viz.* (1) the agricultural patterns obtaining in a tract, depending upon rainfall and facilities for irrigation; (2) nature of the soils, their crop-producing potentials under given conditions and their deficiencies, if any, for optimum crop production and (3) soil crop relationship indicating the nutrient requirements of different crops grown under various soil and climatic conditions.

In the present enlarged Mysore State great diversity is found in the agricultural patterns as well as in soils and climate in the different parts of the State. The rainfall which is of the order of 100–150″ per annum in the western part on the hills as well as on the coast, decreases to less than 25″ in the eastern and north-eastern districts, resulting in an extensive scarcity. In the old Mysore State there was a fairly large network of tanks and at present in both the old Mysore and other areas there are several important major irrigation works where intensive cultivation of a number of crops is possible. Prominent examples of such Projects are the Visvesvaraya Canal system, the Vanivilas Sagar area and the Tunga Canals in old Mysore and the Tungabhadra Project and the Ghataprabha Canals in the Hyderabad and Bombay Karnatak respectively.

The crops grown in the State are equally varied from the common food crops like paddy, ragi and jowar, oilseeds such as groundnuts, gingelly and castor, cash crops like cotton and sugarcane and a variety of plantation crops including coffee, arecanut, cocoanut, and different spice crops such as cardamum, pepper, etc.

With regard to soils they are found to vary due to a combination of geological parent material and the effects of climate. Seven broad groups of soil are at present identified, which are briefly described below.

1. *Trap Soils.*—These are derived from the Deccan trap and occupy large areas in the northern districts of Belgaum, Bijapur, Gulbarga and Bidar. They vary mainly according to the topography

---

* Based on a talk delivered on 15th May 1958 at the First Regional Conference (Soil Test Group), South Zone, held at Bangalore.

** Agricultural Chemist, Mysore Agricultural Department.

being lighter coloured, thin and poor on the highlands and deeper dark coloured and clayey on the lowlands. In texture they vary from sandy loams to clay loams and clays. In the mature phase they are retentive, well supplied with bases and are alkaline in reaction. With good adequate depth and texture they are quite fertile and are capable of producing good yields of a variety of crops, particularly under irrigation. The main crops grown in this region are jowar (*Andropogon sorghum*), cotton (*Gossipium* sp.), groundnut (*Arachis hypogæa*) and several pulses and sugarcane (*Saccharum officinarum*) and paddy (*Oryza sativa*) with sufficient rainfall or irrigation.

2. *Mixed Red and Black soils.*—These soils are found in association with each other and occur in the district of Belgaum, Bijapur, Dharwar, Raichur and Bellary. They are derived either from the gneisses and schists of the Dharwar series of rocks or from the sedimentary rock formation known as the Cuddapah and Vindhya series which include sandstones, shales and limestones and their altered forms. On the uplands they tend to be reddish in colour with coarse texture and on the low lands they are deeper, dark in colour and clayey in texture. In chemical characteristics they show many similarities with trap soils and are quite productive under favourable conditions of rainfall or irrigation. The cropping pattern is also similar to the trap soil region the variations being between the winter (*hingari*) or the monsoon (*mungari*) type of crops.

3. *Red soils.*—An extensive area is covered by these soils in the districts of Kolar, Bangalore, Tumkur, Mandya and Mysore and parts of Hassan, Chikmagalur, Shimoga and Chitaldrug Districts. These soils are derived from acidic granite and do not show regular variation in depth and colour due to topography. They are generally light textured varying from sandy or gravelly loams to loams. They are neutral to slightly acidic in reaction and have low content of bases and other nutrients but respond well to irrigation manuring. Ragi (*Elusine coracana*) is widely grown on this soil mainly as a rainfed crop and paddy, sugarcane and other crops chiefly under irrigation.

4. *Deep Black soils.*—The soils characterised by great depth, deep dark to black colour and a highly clayey texture are grouped under this class. They may be derived from a variety of parent material such as trap, gneisses and schists and sedimentary rocks and often appear to be of mixed origin. They are mostly transported soils and are found to occur in basins of major nalas or river valleys and also appear to be formed in broad depressions in some places. They are generally highly base-saturated, have moderate to high alkaline reaction and show accumulation of lime and soluble salts in lower layers. Consequently, a considerable extent of saline and alkaline soils occur

in this soil group, when there is concentration of salts in the surface or when it has high sodium saturation. This soil group is found to occur mainly in the districts of Bijapur, Dharwar, Bellary, Raichur and Chitaldrug Districts. The black soils are fertile and highly retentive of moisture and can grow very good crops of jowar, cotton and wheat under rainfed conditions; but may not be suitable for intensive irrigation.

5. *Red loam soils.*—They occur in a long narrow strip in the districts of Shimoga, Chikmagalur, Hassan, Mysore and Coorg. They occur in the valley portions adjacent to the fort hills of the Western Ghats and are apparently transported in origin. The soils are mostly loams or silt loams in texture and are comparatively richer in plant nutrients than the red soils. Plantation crops like Coffee (*Coffea arabica*), areca (*Areca catechu*), cardamum (*Elletteria cardamum*), etc. are grown on these soils.

6. *Lateritic soils.*—These soils are derived from laterite and include high level *in situ* soils and low level transported soils. They are found in the heavy rainfall areas of the districts of North and South Kanara, Belgaum, western parts of Shimoga, Chikmagalur, Hassan and Coorg Districts. They are naturally highly leached, show low base saturation and are acidic in reaction. Paddy is the main crop, but some plantation crops like coffee, tea (*Camelia theifera*) and cocoanut (*Cocos nucifera*) are also grown in some districts.

7. *Dark Brown clayey soil.*—This soil occurs in a small area in the eastern part of Coorg Districts and is contiguous with similar dark coloured soil in the south-western part of the Mysore District which forms a forest belt.

Following a broad classification and characterisation of the soils of the region, the next step in the working out of fertilizer recommendations would be the more detailed surveys of the broad soil groups for further subdivision of the groups into types or associations and to determine local variations in fertility and nutrient status. However, chiefly due to both the enormous effort and expenditure which is involved in work of this kind, it has not been possible to undertake detailed surveys to any great extent. But fairly detailed soil surveys have been carried out on lands under command of irrigation from some of the larger projects for the purpose of evolving suitable cropping patterns and general manurial recommendations. Examples of such work include the survey of the Visvesvaraya Canal area[1,2] comprising an area of 1,20,000 acres in Mandya District, survey of the canal area of the Vanivilas Sagar project[3] in Chitaldrug District covering an area of 60,000 acres and the survey of the Tungabhadra Project area in Bellary and Raichur Districts. Survey of a reconnaissance type on

district-wise basis has also been conducted in the districts of Belgaum, Bijapur and Dharwar.

It is, however, obvious that, though the ultimate purpose of soil surveys would be to demarcate individual soil types, determine local variations in nutrients status and thereby lay the foundation for making detailed recommendations to the farmers, work on such extensive scale to be completed within a reasonable time would be beyond the resources of most of the states. The Soil-Testing Laboratories would be able to play an important role in this respect by the collection of analytical data in course of time over a large number of spots situated in the different soil groups and to a certain extent serve as an alternative to such detailed survey work. It may be emphasised at the same time that such analysis would be fully useful only if combined with the soil type for which at least quasi-detailed surveys carried out on the basis of zones in each district would be necessary.

With regard to the second stage of the working out of manurial schedules, *viz.*, studies on the soil-crop relationship, Mysore State can claim to be in the forefront with a long period of activity dating back to as early as 1897. In that year Dr. A. Lehmann was appointed as Agricultural Chemist in Mysore State in charge of all agricultural activities of the State. In fact the Chemistry Division was the first unit to be set up and later on additions of other sections were made to the Agricultural Department. The setting up of the Chemistry Division as a forerunner in the activities of the Agricultural Department was perhaps a sign of the times when the application of Chemistry to agriculture and more particularly of Liebig's mineral theory of nutrition, still held the field. This approach to the work mainly involved the analysis of the soil and the plant for assessing soil fertility and the crop requirements as a basis of recommendation of manurial schedules. Dr. Lehmann, however, carried out the work in a wider field and as pointed out by Dr. B. T. Narayanan,[13] one of the later Agricultural Chemists in the State in a review of the work of the section, that "Dr. Lehmann laid down the fundamental lines on which several problems concerned with soils and crops should be conducted and the manner in which the results should be conveyed to the land-owner."

Dr. Lehmann accordingly carried out comprehensive investigations including pot-culture and field experiments and as referred to in the annual report for 1905 to the starting of the Hebbal Experimental Farm and to the laying out of field experiments on both dry and irrigated crops. He has also referred to the starting of a pot-culture house in the laboratory compound at Bangalore, which was a new line of work in India at that time. He carried out manurial experiments on several crops including important cash crops such as coffee and sugarcane.

In his article on commercial fertilisers[4] published in 1906, Dr. Lehmann has remarked that, with the help of development of agricultural investigations which were taking place at that time, there would be greatly increased demand for commercial fertilisers in the country. He has also stated that as judged by soil analysis, fertilisers were needed in India even more than those countries in which they were being used extensively at that time.

Dr. Lehmann's work left an imprint on the work of the section and Dr. B. Narasimhaiyengar who succeeded Dr. Lehmann and who had a distinguished record of work of over 16 years as Agricultural Chemist, while adhering to the main aspects laid down by Dr. Lehmann, laid greater stress than before on the need for the study of the crops and soils in their natural environment and further developed the work of the field experimentation as an invaluable complement of laboratory trials.

Among the more notable and fundamental contributions made by the section during this time may be mentioned the investigations on "Red soils and their manurial requirements"[5] published by Dr. B. N Iyengar in 1923. This article dealt with pot-culture experiments with *ragi* which showed the necessity of both nitrogenous and phosphatic fertilisers for increasing the yield of this crop.

Similarly, detailed experiments were carried out on the manurial requirements of paddy which were started in 1923, firstly in pots and later in special cisterns of 1 sq. yard in area constructed to enclose natural soil in the field which were devised by Dr. Iyengar. The paddy experiments were continued for 10 years in the cisterns from 1925 to 1935 along with field experiments carried out at Hebbal. The results of the field experiments showed that while the average yields with green manure alone gave 1,684 lb. of grain per acre, the addition of fertilisers at the rate of 10 lb. of N, 25 lb. of P_2O_5 and 50 lb. of K_2O increased the yield by slightly over 300 lb. or approximately 20 per cent. Manurial experiments on several other important crops such as areca, sugarcane, jowar, etc., were also carried out, on the basis of which fertiliser schedules were worked out.

Special mention may be made of a very interesting and unique experiment[6] conducted by Dr. Iyengar in 1924–25 when he started manurial trials on paddy on a cultivator's lands near Mysore which were continued for 20 years. The area in question was about 27 acres in extent and was cultivated on a share basis with the help of 14 tenants each of whom was cultivating varying extents of land. A mixture of 3 parts of groundnut cake, 3 parts of castor cake and 4 parts of superphosphate was applied just before transplanting paddy. This quantity supplied about 12 lb. N and 20 lb. P_2O_5 per acre.

The yields of paddy during all these years were observed to be steadily increasing but tended to be stationary during the last three years of the trial. The average yield per acre before manuring with artificials was only 300 seers of paddy per acre, and this was found to treble itself during the very first year of manuring. During the subsequent years of continuous manuring, this increased yield generally doubled itself, rising from 878 to 1,770 seers per acre. From the results of this trial Dr. Iyengar concluded that even with small quantities of fertilisers but with sustained and long-continued application it was possible to substantially increase the crop yields and build up soil fertility. He also advocated the need for the balanced manuring of crops with both nitrogen and phosphoric acid for this purpose. With regard to application of potash, though no direct responses were found, he opined that responses may set in after some years of application of nitrogenous and phosphatic manures when the available supply of soil potash becomes exhausted.

With the later advent of the application of statistical methods to agricultural experiments, new investigations were started in accordance with standards required by the technique and were carried out for important crops of the State at several research farms representing different soil and climatic conditions. Investigations were also taken up with different manures and fertilisers to determine their effects on the soils and crops and also to evolve and correct techniques of the time and methods of application to attain the best results. Among the notable items of work in this connection may be mentioned the placement of phosphatic fertilisers at suitable depths[7, 8] carried out by Dr. Govindarajan. From these experiments it has been possible to make definite recommendations to apply phosphatic fertilisers at 3–6″ below the soil surface to give the best results. He also carried out detailed experiments on the application of anhydrous liquid ammonia[9, 10] direct to the soil for which a simple applicator was also designed. It has been found that this gave equal yields with ammonium sulphate and that there were negligible losses in applying it directly to the soil for paddy or sugarcane.

From the results of all this work Dr. Govindarajan has finally compiled the manurial formulæ for the principal crops of Mysore State in a departmental bulletin entitled *Manures and Fertilisers*.[11] These recommendations are mainly applicable to the old Mysore State. Similar fertiliser recommendations applicable to parts of Bombay, Madras and Hyderabad States are being collected for the compilation of revised schedule which would be applicable to the present enlarged Mysore State. Many of the recommendations include the application of groundnut cake for supplying part of the manurial requirements

and experiments have been taken up to replace groundnut cake with inorganic or artificial fertilisers in different parts of the State. Attempts are also being made to have the experimentation in the whole State on standard and approved lines with the help of an Agronomical Committee of the Department so as to systematise the work and obtain results of wide applicability.

While fertiliser recommendations described above would mainly apply to conditions of adequate and assured rainfall or having irrigational facilities, mention may be made of the specific work of the formulation of manurial schedules for the dry tracts where the rainfall is low (*i.e.*, less than 25" per annum) and uncertain. Work on dry farming research which was carried out in Bombay and other States showed that, with measures such as bunding for conservation of moisture and other improved techniques of cultivation, yields of jowar and other cereals could be nearly doubled. However, in view of the uncertain rainfall, a minimum quantity of farmyard manure to the extent of 5,000 lb. applying once in 3 years was recommended. Even then the yields were generally low; but in course of time with the gradual improvement of the soil physical condition and the conservation of moisture, it was found that the crops responded well to additional application of 10–20 lb. of Nitrogen and Phosphoric acid resulting in substantial increases in yield. Systematic manurial experiments of this kind have been in progress mainly for jowar at the dry farming research stations which were previously in Bombay, Madras and Hyderabad States and useful data has been obtained on this aspect.

It has now been widely recognised that the results of manurial experiments carried out at experimental stations have necessarily to be tried on cultivators' fields which vary in their degrees of fertility in order to obtain more precise data regarding the responses of fertilisers in different localities. This aspect of the work was given prominence due to the recommendations of Dr. A. B. Stewart and accordingly a number of trials were started in different States. The matter has now been taken up on an All-India basis by the Indian Council of Agricultural Research which has formulated a Scheme on standard lines called the "Co-ordinated Scheme of Simple fertiliser trials on cultivators' fields" to be followed by different States. This Scheme has also been taken up by the Mysore State in which 12 districts have been recommended to be taken up during 1958–59.

It has been possible to study to some extent the working of the fertiliser recommendations of some important crops in actual practise by means of another scheme also sponsored by the Indian Council of Agricultural Research under a joint Indo-American Project on an All-India basis called the "Fertiliser Demonstration Scheme". According

to this Scheme trials are being carried out on cultivators' fields mainly to demonstrate the benefits of fertiliser use to the cultivators. These trials are laid out according to the manurial recommendations at present current in the different States. As has been pointed out in the reports of the trials that the emphasis was on, laying out as large a number of demonstrations without strictly adhering to statistical criteria for carrying out the comparative trials. It is therefore, pointed out that the results have been obtained from a small percentage of the total number of large-scale demonstrations in farmers' fields and not of statistically controlled experiments and thus the relative responses and economics of the fertilisers should be accepted with some reserve.

However, even with the above reservations the results obtained are of interest and indicative of the benefits of fertiliser use in increasing the yields of crops. In the *Kharif* season of 1955–56, which is the main cropping season for the erstwhile Mysore State and to which the latest published report pertains the results of 466 demonstrations laid out on paddy were analysed. The fertiliser doses adopted were 30 lb. nitrogen and 30 lb. P_2O_5 per acre both in the single and combined fertiliser trials. The results showed that very high responses to nitrogen were obtained in all the districts except in Kolar District. The average response to 30 lb. nitrogen was 7·64 mds. of paddy per acre which was similar to the response obtained in the previous year.

The average additional response to phosphatic application was 7·44 mds. per acre which was almost the same as the response to nitrogen alone, the highest response being obtained in Chikmagalur District (12·15 mds. per acre). The average response to the N and P mixed fertiliser (12–6–0) at the level of 300 lb. per acre was 9·15 mds. per acre and with 450 lb. of the mixed fertiliser the response was increased to 17·15 mds. per acre. The average profit per acre due to application of 30 lb. nitrogen was calculated as Rs. 50 and average profit due to application of 30 lb. P_2O_5 as Rs. 49. The above results have been given as an example of the working of the Scheme. The Scheme is being extended to the other districts under the present set-up of enlarged Mysore State.

The working out of fertiliser recommendations is a continuous process as it has to deal with changing conditions of soil fertilitity, cropping patterns, introduction of new fertilisers, new crop varieties, improved methods of fertiliser application and so on. Accordingly continuous experimentation and research is also necessary. As has been already mentioned earlier, a co-ordinated plan of experimentation is being taken up in the State dealing with all agronomical aspects including manuring at the various research stations of the State. The

Indian Council of Agricultural Research has also sponsored a number of selected centres all over India for conducting model agronomical experiments on important crops in order to obtain scientific information on the individual, aggregate and cumulative effects of numerous growth factors under different conditions of soil and climate. Two such centres are in operation in Mysore State at Shimoga and Gangavathi (Raichur District) and a third one is being started in Coorg District. All this work of experimentation will naturally yield valuable data not only on the manuring aspect but also on improved methods of cultivation which are essential for making the application of fertilisers fully effective.

We now come to the most important aspect of the responses of fertilisers, *viz.*, the correlation of yield increases with the level of soil nutrients or other factors. In fact the ultimate object of manurial investigations would be the drawing up of exact correlations between soil factors and increses in crop yield under given conditions so as to fix upon the optimum quantities of fertiliser constituents necessary to give economic yields. This would help in the judicious use of fertilisers to the extent which they are actually needed and utilise the fertiliser resources to the best advantage.

In this work the Soil-Testing laboratories have been called upon to contribute to the important work of carrying out soil analyses in the fields where the trials would be laid out in the cultivators' fields under the co-ordinated simple fertiliser trials scheme. By this means a large volume of data will be available from which correlations can be drawn under different conditions. It is also intended to undertake soil analysis in the experimental plots in the model agronomic trials scheme so as to follow up the soil changes and improvement in soil fertility by manuring.

It is hoped that all the above mentioned work will in the near future lead to the formulation of more precise fertiliser recommendations in the State which would increase and maintain agricultural production at a high level.

References

1. Narasimhaiengar, B. (1934), *Irwin Canal Soil Survey Report*, Series 1.
2. ——— (1938), *Ibid.*, Series 2.
3. GovindaRajan, S. V. (1954), "Vani Vilas Soil Survey," *Soil Survey Report*, No. 3.
4. Lehmann, A. (1906), *Commercial Fertilizers.*
5. Narasimhaiengar, B. (1923), "Red soils and their manurial requirements," *Mys. Agri. Jour.*, 5.
6. ——— (1944), "Twenty years of manuring with paddy," *Ibid.*, 23, . .

7. Govinda Rajan, S. V. and Venkata Rao, B. V. (1952), "Manures and Fertilizers: Their efficient and effective use for increased crop production," *Mys. Agri. Jour.*, **28** (4).

8. Govinda Rajan, S. V. (1953), "Better use of phosphatic fertilizers," *Agl. Chem. Series, Bull.* No. 2, Department of Agriculture, Mysore.

9. ——— (1956), "Anhydrous ammonia as a nitrogenous fertiliser," *Chem. Series, Bull.* No. 4, Department of Agriculture, Mysore.

10. ——— and Venkata Rao, B. V. (1957), "Anhydrous ammonia as a fertiliser—Its retention in soils and value as a fertiliser," *Jour. of Ind. Soc. of Soil Sci.*, **5**.

11. Govindarajan, S. V. (1955), "Manures and Fertilisers—Manurial formulæ for the principle crops of Mysore State," *Chem. Series, Bull.* No. 1, Department of Agriculture, Mysore.

12. State Department of Agriculture, Bombay (1951), *Artificial Fertilisers for Crops in Bombay*, Leaflet No. 5.

13. Narayanan, B. T. (1944–45), "The chemical section," *Mys. Agri. Jour.*, **23** (2), 47–53.

(Received: 2nd June 1958)

THE AGRICULTURAL IMPORTANCE OF THE INTERRELATIONSHIP BETWEEN THE ION-EXCHANGE CAPACITIES OF SOIL AND PLANT ROOT WITH REFERENCE TO NUTRIENT UPTAKE BY PLANTS

By T. Seshagiri Rao*

Introduction

The ion-exchange capacity of the soil was discovered about a hundred years ago while the existence of cation exchange properties of plant roots was reported by Devaux in 1916. The roots of plants also possess considerable exchangeable capacity, usually in the order of 10–20 milli-equivalents per 100 g. dry weight. As a result of exhaustive studies on soil-plant relationships it has been shown by Jenny and Overstreet (1939), Mehlich and Coleman (1952), Drake (1951), Krishnamurthy (1957) and others, that the nutrient intake is greatly influenced by the clay mineral and the degree of base saturation. This factor has an important bearing on the fertilizer practices on various types of soils and crops and in the correct interpretation of field results obtained.

Clay Colloids and Bounding Energies for Cations

Although there exist several kinds of clay minerals, we may for our discussion include the two, namely, the Montmorillonite and the Kaolinite, as these two types represent distinct contrasts and the properties of other types are more or less intermediate between the two. Montmorillonite, a colloid of high cation exchange capacity, attracts calcium with much greater energy (Ca Montmorillonite = 1396 calories per mol), than it would potassium (K Montmorillonite = 710 calories per mol). Kaolinite, with low cation exchange capacity, would attract potassium with greater bonding energy than it would calcium. A given clay has different bonding energies for different cations and different clays have different bonding energies for a given cation. For instance, potassium is held by Montmorillonite and Beidellite with 710 and 1544 calories per mol. respectively, while calcium is held by Montmorillonite and Beidellite with 1396 and 2670 calories per mol respectively (Bear, 1955). As the calcium saturation becomes lower, the decrease in availability of calcium is greater in Montmorillonite than in Kaolinite. Thus, in general, in soils predominantly of the 1 : 1 type (Kaolinite) calcium availability is higher than in soils of the

* Lecturer in Agricultural Chemistry, College of Agriculture, Hebbal.

2:1 type (Montmorillonite). The soils of the latter class require liming to a higher degree of calcium saturation whereas smaller amounts of lime are needed to bring the former soils (1:1 type) to a given degree of calcium saturation. With increasing cation exchange capacity the relative availability of potassium also increases and thus potassium is more easily available in 2:1 type than in 1:1 type of soils.

Plant Roots as Ion Exchangers

There are plant roots with high and low exchange capacities and the cation exchange capacities of few plants are given in Table I.

Table I

Cation Exchange Capacity of Plant Roots

Plant Species	Cation Exchange Capacity (me/100 g. dry weight)
Dicotyledons	
Lettuce	65·1
Soyabeans	65·1
Blue lupine	53·3
Peanut	36·5
Cotton	36·1
Monocotyledons	
Rye grass	22·5
Corn	17·0
Millet	12·2
Winter Wheat ..	9·0

(Drake *et al.*, 1951)

From Table I it may be seen that generally Dicotyledons have high cation exchange capacity and Monocotyledons have a low cation exchange capacity. The cation exchange capacity of the root itself is a function of its ability to produce carbon dioxide may be seen from Table II.

Plants with thick and coarse roots, like legumes, produce more carbonic acid and have high cation exchange capacity. Such plants have

TABLE II

Carbon Dioxide Production and Root Exchange Capacity

Plant	Carbon Dioxide Respiration mg./g. in 24 hours	Cation Exchange Capacity me/100 g.
Wheat	74·6	9·0
Barley	70·5	12·3
Red clover	146·8	47·5
Alfalfa	160·5	48·0

(Mehlich and Coleman, 1952)

high bonding energy for calcium and low bonding energy for potassium. Plants with thin and fibrous roots (cereals and grasses) produce less carbonic acid and have low cation exchange capacity. Such plants have low bonding energy for calcium and high bonding energy for potassium. In the presence of carbonic acid more of calcium dissolves and becomes available while in the absence of carbonic acid less of calcium becomes soluble and so relatively more of potassium is absorbed (Table III).

TABLE III

Bonding Energies of Root Colloids

Plant	Cation Exchange Capacity	Saturated Cation	Mean-free Bonding Energy in Calories per mol.
Alfalfa	42·4	K	672
		Ca	1549
Reed Canary Grass ..	11·8	K	272
		Ca	314

Plants with different cation exchange capacities will absorb different cations in different amounts. "The root colloid and the soil colloid compete for cations, and the cation uptake by the plant depends upon the relative exchange capacities of the root and soil."

Thus, legumes contain larger amounts of calcium and magnesium, not because they require large amounts of calcium and magnesium, but because the nature of root colloid causes the roots to adsorb larger amounts of these divalent cations. Cereals and grasses absorb potassium in larger amounts on account of their low cation exchange capacity.

Factors Affecting Nutrient Intake by Plants

It is, therefore, evident that nutrient intake varies with the plant due to the interplay of various relationships discussed above. A given plant absorbs the same cation in different amounts from different clay systems and in the same clay the nutrient intake varies with the percentage saturation. This is clearly revealed by the differential uptake of calcium by peanuts from different clay systems and at different percentage base saturation as shown in the data given in Table IV.

Table IV

Differential Uptake of Calcium by Peanut

Plant	Type of colloid	Total cation exchange capacity of soil	Amount of exchangeable calcium	Percentage saturation	Amount of calcium taken up by the plant
Peanut ..	Montmorillonite	0·8 me	0·64 me	80	7 me.100 gm.
		2·4 me	0·64 me	27	3 me.100 gm.
	Kaolinite	0·8 me	0·64 me	80	7 me.100 gm.
		2·4 me	0·64 me	27	7 me.100 gm.

(Bear, 1955)

It may be noted from Table IV that at high percentage saturation (80 per cent.) the intake of calcium has not been affected by the type of clay colloid but at a lower percentage saturation (27 per cent.) the plant has taken more calcium from Kaolinite than Montmorillonite, although the actual amount of calcium present is same in all cases. Hence the nutrient intake varies with the plant.

Kaolinite and Potassic Manuring

In the light of the above discussion a few experimental results obtained under Indian conditions may be examined. The laterites and lateritic soils, coffee and tea soils on the plantations and red sandy loams respond to potassic manuring. This is in accord, for potassium availability is low in soils containing Kaolinite, which is the main

clay mineral present in the above soils. These clays hold potassium with greater bonding energy and so little potassium is available for plants. Hence the need for potassic manuring of these soils. If in addition the crop roots have low cation exchange capacity, the deficiency of potassium is accentuated. These soils are usually acidic and they are limed to decrease the hydrogen-ion concentration. In liming care has to be bestowed for overliming depresses the availability of potassium by reducing its percentage saturation. Another interesting feature noticed is that with moderate amounts of lime good growth of legume can be obtained on these soils. It is reasonable to expect this, for, Kaolinite has low bonding energy for calcium and so all calcium is available to the legume, which as pointed out earlier, absorbs calcium in large amounts.

Rock Phosphate and Legume

The fact that legumes utilise Rock Phosphate better than other crops can also be explained on the same reasoning. The roots of legume with its high bonding energy for calcium splits the Rock Phosphate molecule and sets free phosphate ion which can be assimilated directly by the plant or the associated cereal if grown along with the legume.

The Availability of Cation in Black Cotton Soil

The black soils usually contain clays of 2:1 type and in them the availability of potassium is greater than calcium. Because of the higher bonding of these clays for calcium, the latter is available to the plant with difficulty in these soils although this may appear strange in spite of the calcareous nature of these soils. It is believed that only above a particular base saturation, which may be as high as 70 per cent., calcium is available for plants. Bear and Toth (1948) have reported that under New Jersey conditions the exchange complex should be made of 65 per cent. Ca, 10 per cent. Mg, 20 per cent. H and 5 per cent. K for satisfactory supply of nutrients to the plant and they call such a soil "ideal". Hence on theoretical considerations it would appear that these soils may not respond to potassic manuring to the same extent as soils of 1:1 type. It is now understandable why response to potassic manuring has not been uniform on all types of Indian soils. It should be ascertained by planned experiments on these soils the need for potassium application and if so to what extent. A judicious application of potassium on such soils is necessary for indiscriminate application will depress the availability of calcium by lowering the percentage saturation of the latter still further.

Conclusion

Thus, it may be seen, the mineral nutrition of a plant is influenced to certain extent by the type of soil colloid. The practical importance of the mineral nutrition of plants with reference to type of clay colloid has not received as much attention as it needs. A thorough knowledge about them will enable us to correctly interpret the field results on fertilizer responses, which apparently seem to run counter to popular belief. Hence in the interpretation of field results and chemical soil tests an understanding of the interrelationship between soil and root colloid, type of clay colloid and percentage base saturation is of special importance.

References

1. Drake, M., *et al.*, (1951), "Cation exchange capacity of plant roots," *Soil Sci.*, No. 72, 139–47.
2. Firman Bear, E. (1955), *The Chemistry of the Soil*, Reinhold Publishing Corporation.
3. Mehlich, A. and Coleman, N. T. (1952), "Type of soil colloid and the mineral nutrition of plants," *Advances in Agronomy*, 4, 67–99.
4. Jenny and Overstreet (1939), "Cation interchange between plant roots and soil colloids," *Soil Sci.*, No. 47, 257–72.
5. Krishnamurthy, Ch. (1957), Lecturcs to Soil Conservation Trainers.

(Received: 4th June 1958)

Research in Progress

At the Government Agricultural Farm and Rice Breeding Station, Ponnampet in Coorg District, attempts are being made to select rice varieties and strains that are resistant to Blast disease (*Piricularia oryzæ*). In persuance of the above, during the quarter under report, selections were made within the varieties and comparative study undertaken to find out their responses to 'Blast' infection. Some trials of varieties resistant to the above diseases were also undertaken in co-ordination with the Central Rice Research Institute, Cuttack. In addition to the above tests, experiments have also been initiated to study treatment of soil with trace elements and chemical treatments of the crop with 0·5 and 0·1% Bordeaux sprays, 1·0% ceresan spray and dusting with sulphur.

In the scheme for research on forage crops at Kudige in Coorg District, 26 varieties of grasses and 7 varieties of legumes are under trial. In the yield trials "Amphidiploid of Cumbu × Napier", gave the highest yield amongst the grasses during the quarter under report while amongst the legumes 'Kudzu' (*Pueraria phaseoloides*) yielded best. In general, growth of all the grasses was good, *Dicanthium annulatum* and *Dicanthium cariclosum* deserving special mention. In the manurial trials conducted on 'Para' grass (*Brachiara mutica*) treatment with 20 lb. of P_2O_5 per acre as superphosphate was found to give higher yields.

In the Division of Entomology at Bangalore, studies on the importance of Cicadellids on sugarcane were taken up and the biology of one of them *Tettigella spectra* Dist. was completed. The bionomics of the castor pod-borer, *Dichocrocis punctiferalis* Guen, was also studied and it was found that the life-cycle of the pest occupies 30–36 days. Eggs are found laid mostly on the mature pods, a factor which has been observed for the first time. Observations on the seasonal history of the brinjal fruit-borer *Leucinodes orbonalis* G., revealed its uninterrupted activity all through the year round either in vegetative shoots or in fruits. Its incidence was on an average 10% during the quarter. Preliminary studies on the insects affecting *Sesbania indica* which is grown as a green manure crop and also as 'prop' in betelvine gardens were initiated. Insecticidal trials against the citrus leaf-miner (*Phyllocnistis* spp.) revealed that amongst the several insecticides tested, 0·04% spray of 'Ekatox-50' was superior to others. Two sprayings

at an interval of a week are found necessary for a complete control of the insect. Acaricidal trials against the fig-mite (*Eotetranychus hirsti* P. & B.) revealed that a number of chemicals—Ekatox, Malathion, Ultra-sulphur, Aramite and Akar do give encouraging results. Exploratory trials with two proprietary weedicides—'Nata' and 'Kathan M-7' were carried out against weeds like Hariyali (*Cynodon dactylon*), Nut-grass (*Cyperus rotundus*) and *Oxalis*. 'Nata' gave encouraging results against Hariyali and Nut-grass, in that there was no sprouting within one week after treatment.

At the Agricultural Research Station, Alnawar, agronomical experiments on sugarcane were continued. In the standing experimental crop, the varieties Co. 678 and Co. 740 showed a better stand and growth than the other varieties under trial. In the ratio experiments on plant cane and ratoon, the treatments receiving 100 lb. P_2O_5 showed a better growth. Likewise, different treatments receiving N.P.K. along with minor elements in the 'Change of Seed' experiment have revealed a better crop growth.

— (D. V. M.)

Abstracts

AGRICULTURAL CHEMISTRY

1. Karlovsky, J. (1957). "No benefit from sub-surface placement of phosphatic fertilisers in pasture," *New Zealand Journal of Agriculture*, **95** (3), 245.

Though recent experiments have shown that row crops use phosphate better when it is placed close to the roots than when it is broadcast, no similar beneficial effects in pastures by sub-surface placements of phosphatic fertilisers were obtained on loamy soils. On the contrary, the implement specially designed to place fertilisers at varying depths in pasture, depressed growth and the fertiliser so placed did not encourage deeper rooting of species. Following are the conclusions.

(i) Sub-surface placement of phosphatic fertilisers at 4″, 6″ and 8″ resulted in lower pasture yields than did surface placement.

(ii) The deeper the phosphates were placed the lower was the production.

(iii) Sub-surface placement of phosphates did not encourage deeper rooting.

(K. SHANKAR)

2. Anonymus. (1955–56), *The report of the results of fertiliser demonstration trials in India*, Indian Council of Agricultural Research, Ministry of Food and Agriculture, Government of India, New Delhi.

An All-India Fertiliser demonstration Trials scheme was sanctioned by Government of India in March 1954 and demonstrations were started, in 1954. Simple 3 plot demonstrations were conducted on cultivators fields to demonstrate the effectiveness of Urea, Ammonium sulphate, Ammonium sulphate-nitrate and NP mixtures. The report deals with the results obtained from the 7,600 demonstrations. The response of crops to N, P and mixed fertilisers are discussed in detail in addition to fertiliser response in relation to soil type and economics of manuring.

Paddy

(i) *Response to nitrogen.*—Very good responses to 30 lb. of N were obtained, the response varying from 4 maunds in Madras to 8 maunds

in Mysore State, the average being between 4 and 5 maunds in most of the States per acre.

(ii) *Response to phosphate.*—Application of phosphate in addition to nitrogen gave extra response in all the States, the average for 30 lb. of P_2O_5 ranging from 2·6 maunds to 6·83 maunds per acre.

(iii) *Source of nitrogen.*—Responses to Urea were in general higher than to that of Ammonium sulphate-nitrate which in turn has generally indicated better response than Ammonium sulphate.

(iv) *Fertiliser response in relation to soil type.*—A good response to nitrogen was obtained in most of the soil types the same being highest in old alluvium, red and gravelly soils and moderate to low in coastal alluvium, new alluvium and delatic soils. Response to phosphate was obtained in all soils, the same being highest in red gravelly soils of Mysore.

(v) *Economics of manuring.*—Application of N in the form of ammonium sulphate gave an average profit of Rs. 31 per acre. Urea and Ammonium sulphate-nitrate gave higher profits. P_2O_5 at 30 lb. per acre gave an additional profit of Rs. 19 per acre which is twice the investment on the said fertiliser.

Other Crops.—The response of *Jowar* and *Bajra* were low with N, P_2O_5 and mixed fertiliser. A good response to N was obtained for ragi in Madras.

(K. SHANKAR)

3. Nair, K. S., Varadarajan and Mariakulandai (1958), "Studies in green leaves—seasonal variations in the N and C contents of green leaf manures," *Madras Agricultural Journal*, **45** (3), 114–19.

A comparative study was made for one year at monthly intervals of the green leaves of (*a*) *Glyricidia maculata*, (*b*) *Pongamia glabra*, (*c*) *Delonix regia*, (*d*) *Enterolobium saman*, (*e*) *Thespesia populnea*, (*f*) *Azardirachta indica*, for total nitrogen and organic carbon. The experiment indicates that (1) though there is variation in the N and carbon content of the different green manures, there is no variation in one and the same leaf manure due to season and (2) the green leaves of any of the trees studied may be used for green manuring purpose or for composting at any time of the year.

(K. SHANKAR)

4. Beckmann, T. J. (1958), "Effect of Molasses and formalin on the soil structure and prosuction of forest nursery seed beds. *Queensland Journal of Agricultural Science*, **14** (2), 111–17.

Application of molasses to selected forest nursery soils improved soil structure. The improvement was reflected in growth of seedlings and the proportion of plantable stock obtained. The increases in growth were greater than those obtained with partial soil sterilization.

(K. SHANKAR)

5. Rouquerol, P. (1957), "Problem of fertilization in South America," *Potash Review*, Subject 18, suite 4.

The term "Fertilization" is defined as the art of making soils fertile, *i.e.*, making them highly productive. In Agronomy, it is the art of applying fertilisers or soil amendments with a view to raise the level of productivity. Thus, in South America, the problems of fertilization are initially the problems of soil-conservation, irrigation, improved methods of cultivation and finally, of fertiliser dressings. The climate, zones of vegetation and their special features in South America and measures required to increase fertility and the economic aspect of fertilization are discussed.

(K. SHANKAR)

6. Bertus, A. L. and Abeygunawardena, D. V. W., (1957), "Soil conditions and seedling blight of rice," *Tropi. Agric.*, **131** (2), 147.

Soil moisture was found to be a critical factor governing infection of rice seedlings to *Fusarium moniliforme*. At higher soil moisture levels the infection was less and *vice versa*. Soil texture and composition did not seem to affect the infectivity of the pathogen for the same trend was observed in both clay and sand. It is suggested that the infectivity can be controlled by saturating the soil.

(T. SESHAGIRI RAO)

7. Cooper, W. C. (1957), "Comparison of several iron-chelating agents in correcting iron chlorosis in Dancy tangerines in the Rio Grande Valley," *Horti. Abst.*, **27** (4), 3841.

Soil applications at the rate of 1–5 gm. of metallic iron per tree, of Versenol Iron Chelate NaFe, Chel 138 HFe, RA 157 Fe and RA 159 Fe (cheleting agents), were made to three-year-old Dancy tangerine tress on chleopatra mandarin root stock growing on calcareous soil and showing severe iron chlorosis. The two compounds Chel 138 HFe and RA 157 Fe were found to be highly effective even at 1 gm. rate of application as judged by the decrease in chlorosis during a two-month period following treatment.

(T. SESHAGIRI RAO)

AGRONOMY

8. Holiday, D. J. (1957), "The Manuring of Sugarcane," *Outlook on Agriculture*, **1** (6), 223–29.

The present position and future trends of manuring of Sugarcane in different countries are summarised in this paper. It has been stated that more research has been done on Sugarcane than on any other tropical crop and as a result, world production has gone up three times although the area under Sugarcane has just doubled. Different methods employed for estimating the nutrient requirements of this crop such as soil analysis, foilage analysis are discussed. It has been predicted that in future diagnostic technique would be fully utilised and better methods of placement of fertilisers would be employed. The author has emphasised the need for more research on crop rotation and conservative practices designed to maintain fertility at high level.

(H. R. Arakeri)

ENTOMOLOGY

1. Nagaraja Rao, K. R. (1958). "Controlling Stem-Borer by Systemic Insectides," *Rice News Teller*, **6** (2), 3–4.

The author conducted trials at Coimbatore in Madras State with three systemic insecticides, Pestox 3 H, Systox and Folidol E. 605 as sprays against the Rice Stem-borer—*Sehœnobius incertulas* Wlk. Pestox 3 H and Systox were applied at a concentration of 0·075 per cent. while Folidol E. 605 was applied at 0·05 per cent. Three rounds of spraying were given, *viz.*, the first 10 days before lifting the seedlings from the nursery, the second 20 days after planting and the third at the shot blade stage of the crop so as to coincide with the season of mass emergence of the stem-borer moths. The results obtained show that both Folidol E. 605 and Systox are effective in not only reducing the incidence of infestation but also in increasing the yield of the crop. From economical and toxicity points of view the author recommends spraying with Folidol E. 605.

(D. V. M.)

2. David, S. Kanakaraj (1958), "Insects and Mites Affecting Jasmine in the Madras State," *Madras agric. J.*, **45** (4), 146–50.

Brief notes on the following insects and mites affecting Jasmine (*Jasminum* spp.) are given: *Hendecasis duplifascialis*, (Pyralidæ: Lepidoptera), *Elasmopalpus Jasminophagous* (Pyralidæ: Lepidoptera), *Contarinia*

maculipennis Felt (Cecidomyidæ: Diptera), *Margaronia unionalis* Fabr. (Pyralidæ: Lepidoptera), *Nausinœ geometralis* (Pyralidæ: Lepidoptera), *Orthacris simulans* (Acrididæ: Orthoptera), *Antestia cruciata* Fab. (Pentatomidæ: Heteroptera), *Ricania fenestrata* Fabr. (Fulgoridæ: Homoptera), *Flata ocellata* Fab. (Fulgoridæ: Homoptera), *Dialeurodes kirkaldyi* (Aleyrodidæ: Homoptera), *Pseudococcus virgatus* (Coccidæ: Homoptera), *Leptopharsa ayyari* Dist. (*Tingidæ*: Heteroptera), *Isoneurothrips orientalis* (Thripidæ: Thysanoptera), *Tetranychus cucurbitæ* (Tetranychidæ: Acarina) and *Eryophyes* sp. (Eryophyidæ: Acarina).

(D. V. M.)

3. Kiyoaki Koidsumi, Biological Laboratory, University of Gifu, Nagara, Gifu, Japan (1957), "Antifungal Action of Cuticular Lipids in Insects," *J. ins. Physiol.*, **1** (1), 40–51.

Larvæ of the silkworm (*Bombyx Mori* L.) and the Rice Stem-borer (*Chilo simplex*) becomes highly susceptible to muscardines when their cuticular lipids are either mechanically or chemically removed. Lipids contained in the shed cuticles of silkworms have either a fungicidal or fungistatic action, according to concentration.

(D. V. M.)

4. Graham, W. M. and Kockum, S. (1958), "Fumigation under a polyethylene envelope," *Nature*, **181** (4624), 1675.

The authors report a new method of fumigation which involves the sealing of stacks with a polyethylene cover (2/1,000 inch thick) and fumigating with methyl bromide under such a gas-permeable covering. In large-scale experiments polyethylene sheets were compared to gas-proof "Neoprene" on Nylon Sheets and it was observed that the losses of gas through the former are restricted to loss by diffusion. After 48 hours most of the gas is found sorbed by the product and the danger in entering the store after 72 or 96 hours is negligible. When all in gas has been sorbed and broken down chemically, the bromine content in the product is still below toxic levels. The authors however envisage the possibilities of using a much stronger (5/1,000 inch) polyethylene together with a seal against reinfestation in the form of a heavy strip of insecticidal dust around the edge of the stack to completely protect the grains. This improved method will be very economical in that there will be no necessity for additional fumigation.

(D. V. M.)

5. Moudgal, N. R., Raghupathy, E. and Sarma, P. S. (1958), "Influence of Some Iodoamino-acids and Iodoproteins on the growth of *Corcyra cephalonica* St.," *Nature*, **181** (4624), 1655–56.

In a study on the effect of Thyroxine, Tri-dothyronine, Thyroxamine, Thyroglobulin and Iodocasein on the growth of *Corcyra* larvæ it has been found that Tri-dothyronine produces the maximal growth response. All the test compounds detailed above influence the metamorphosis of the *Corcyra* larvæ into adult moths. Apart from accelarating the onset of emergence of moths from the pupæ, the percentage of larvæ reaching maturity is also high.

(D. V. M.)

6. Cornwell, P. B. and Burson, D. M. (1958), "Grain weevils, *Calandra granaria* L. and *C. oryzæ*, reared on irradiated wheat," *Nature*, **181** (4625), 1747–48.

The note is a preliminary communication as to whether irradiation of the wheat by γ-radiation would affect its suitability as a culturing medium for grain weevils. It has been shown that grain treated with doses of upto 50,000 rads may be used for rearing *C. granaria* and *C. oryzæ* without adversely affecting their development. Further investigations are in progress to ascertain the possibility of using insects to detect the changes in the nutritional value of foodstuffs when irradiated with doses of 0·1–1 megarad.

(D. V. M.)

7. Kessler, B., Swirsk, E. and Tahori, A. S. (1958), "Effect of Caffeine and other purines upon the Ribonucleic Acid/Deoxyribonucleic acid ratio in leaves and the suitability of these leaves for aphids," *Nature*, **181** (4623), 1595–96.

In an investigation on the relation between changes in the Ribonucleic acid/Deoxyribonucleic acid ratio with ageing of the leaves and their suitability as food for aphids, the authors have found that this ratio increases with age and that variation in this ratio can also be induced experimentally, for example by the addition of caffeine. It is interesting to note that aphids develop to a much lesser extent on mature leaves and on leaves pretreated with caffeine. It is assumed that the effect of caffeine on aphids is brought about by induced metabolic changes in the leaf, which resemble those found in maturing leaves.

(D. V. M.)

8. Durr, H. J. R., Joubert, C. J. and Walters, S. S. (1958), "The effect of application to the soil of Aldrin, Cieldrin and Chlordane on

infestations of the Argentine Ant (*Iridomyrmex humilis*) during a period of four years," (in Afrikans with a summary in English), *South African Journal of Agricultural Science*, **1** (1), 75–82.

Aldrin, Dieldrin and Chlordane were applied to separate experimental plots in a Vineyard at Stellenbosch at the rate of 4 lb. technical material per morgen by mixing the insecticides with moist sand and broadcasting the material over the surface of the soil. After application of the material the plots were cultivated. While at the beginning of the experiment the vines in all the plots were heavily infested with *Iridomyrmex humilis* and mealy bugs the above pests had completely disappeared 8 months after treatment. Even four years after the treatment the soil in all treated plots remained highly toxic to the ants. At this stage while Aldrin concentration in the soil showed a sharp decrease, more than half the original amount of Chlordane and Dieldrin was still found.

(D. V. M.)

News & Notes

The Managing Committee of Mysore Farmers' Forum at its meeting held on 27–4–1958 elected Shri R. Narasimhiah as Hon. Secretary of the Forum for the current year.

Shriyuts L. T. Karle and V. Masiappa, two of the Vice-Presidents of the Forum, have been chosen as Farm Leaders to visit United States of America.

Farmers' Week and District Seminars are being organised throughout the State with the help of N.E.S. and C.D. Blocks authorities.

Formation of Seed Growers' Association at Taluk level has been taken up to augment pure seed distribution. It is happy to note that Malavalli Taluk Branch is making a headway in this respect.

Bangalore District Vyavasaya Sangha is making arrangements for starting a Co-operative Society for perishable articles to aid the producers with market facilities; thanks to the kind help and guidance given by the Deputy Commissioner, Bangalore.

Bijapur District Vyavasaya Sangha at its meeting held in the middle of May 1958 have decided to expand the activities of the Sangha and for starting an Association of registered and certified seed growers.

A Taluk Branch under the leadership of Shri B. M. Horakeri has been organised in Badami Taluk in Bijapur District.

Dr. Panjabrao S. Deshmukh, Union Minister for Co-operation and President, Farmers' Forum, and Young Farmers' Association, India, paid a visit to the Office of Mysore Farmers' Forum on 2*nd July* 1958 and addressed the Members. Glyricidia seedling project in the Office compound was appreciated by the Minister. He was pleased to express that these twin organisations of Farmers should grow from strength to strength and bring an awakening in our outlook on farming. The Bangalore North Taluk Young Farmers' Association had arranged a Rally of their Taluk Clubs and an Exhibition at Dasarahalli. Dr. Deshmukh participated in the function along with Shri K. F. Patil, our President.

The Quarterly Meeting of the State Research Council was held at Bangalore on 5th and 6th June 1958 under the Chairmanship of Shri M. Mallaraj Urs, Director of Agriculture, when the progress of all Research Schemes were reviewed. The next Quarterly Meeting of the Council is proposed to be held at Dharwar in September 1958.

884-58 Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent edited by Dr. H. R. Arakeri and published by Secretary, Mysore Farmers' Forum, Cenotaph Road, Bangalore-2

Dr. P. S. Deshmukh addressing members of the Mysore Farmers' Forum at the Forum Office on 2nd July 1958